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EEnvest

Risk reduction for Building Energy Efficiency investments

Demo-case technical/financial due diligence

This project has received funding from the European Union's Horizon 2020 research and innovation programme under Grant Agreement n. 833112

Abstract

The EEnvest project aims to develop a web-based energy efficiency investment evaluation platform (EEnvest platform) for financiers, private investors and building owners (project owners) based on the EEnvest methodology. This methodology identifies, assesses and calculates technical and financial risks and performs multiple-benefits analysis of the energy efficiency projects uploaded to this EEnvest platform.

To do so the EEnvest platform heavily relies on the input data provided by the user of the EEnvest platform before the implementation of the ECM and before financing has been secured. The quality of the output data provided by the EEnvest platform is thus highly influenced by the quality of the provided input data. An early indication of the quality of design, implementation, operation and the related risks of an energy efficiency project can be assessed by carrying out a due diligence.

The purpose of this work is twofold: firstly, to provide an approach for project quality assessment based on a desktop due diligence methodology applied to the demo-case buildings in Italy and Spain and secondly, to provide an approach for input data quality assurance related to the EEnvest methodology of technical and financial risk assessment and multiple-benefits analysis.

The desktop due diligence methodology consists of a desktop due diligence questionnaire and a related scoring methodology covering the different stages or Themes of an energy efficiency project. Its output is an indication of the probability that an energy efficiency project will achieve its objectives or intended results. For the Italian and Spanish demo-case an analysis of the answers of the questionnaire is being performed, together with an interpretation and discussion of the obtained scorings, followed by relevant recommendations to improve the set-up and implementation of their respective energy efficiency projects.

The approach for input data quality assurance provides recommendations, suggestions and guidelines on what kind of data and how data need to be collected, elaborated and adjusted and what needs to be in place to assure high quality input data in the framework of this EEnvest methodology. Hence, providing an approach to the execution of a due diligence as per this EEnvest methodology.

The EEnvest project will investigate the integration of the Desktop Due Diligence Questionnaire and its related scoring in the EEnvest web-based investment evaluation platform.

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List of abbreviations and acronyms

DDDQ	Desktop Due Diligence Questionnaire
DER	Deep Energy Renovation
ECM	Energy Conservation Measure
EE	Energy Efficiency
EPC	Energy Performance Contracting
HVAC	Heating, Ventilation and Air Conditioning
ICP	Investor Confidence Project
IPMVP	International Performance Measurement and Verification Protocol
LEED	Leadership in Energy and Environmental Design
MB	Multiple Benefit
M&V	Measurement & Verification
O&M	Operation & Maintenance
RES	Renewable Energy Sources

1 INTRODUCTION

The EEnvest project's objective is to develop a web-based energy efficiency investment evaluation platform (EEnvest platform) for financiers, private investors and building owners (project owners) that identifies, assesses and calculates technical and financial risks related to the energy efficiency projects uploaded to this EEnvest platform.

To be able to perform the necessary technical and financial analyses and calculations the EEnvest platform requires user input data such as building technical data, energy efficiency measures, expected energy savings, economic data and financial data but also integrates other required data such as climate data and macroeconomic data obtained by the platform itself. In addition to the technical and financial analyses and calculations the EEnvest platform performs multiple-benefits analysis based on the envisaged energy efficiency measures of the related energy efficiency project.

Based on the specifically required input data of the related energy efficiency project the EEnvest platform translates the aforementioned identified, assessed and calculated risks into financial and multiple-benefits outputs and relevant Key Performance Indicators. By doing so the platform is providing valuable information to investors by supporting them in their energy efficiency investment assessment and by addressing certain reservations they have about the financing of energy efficiency investments. These reservations consequently make the investors less attracted to financing energy efficiency projects as the latter are often seen as:

- complicated
- subjected to higher risk
- uncertain as to the discrepancy between the predicted and actual results (energy savings, operating costs...)
- lacking standardisation
- lacking information.

The provision of key economic, technical, financial and multiple benefits information, as intended by the EEnvest platform, addresses most of the above-mentioned issues, as enhanced knowledge of risks and their quantification reduces the uncertainty and reservations surrounding energy efficiency investments. Hence it will allow investors to take more educated investment decisions.

Nevertheless, the assessment and calculation of risks and multiple benefits relies heavily on the provided input data by the user of the EEnvest platform. The quality of the input data is thus highly influencing the quality of the output data provided by the platform. As one of the most important features of the platform relates to the matchmaking between project owners and investors in order to facilitate deal flow and investment, this input data is normally being provided before the implementation of the ECM and before financing has been secured.

These early-stage input data culminate in expected or intended results and relate, for instance, to ECM to be implemented, expected or intended energy savings and forecasted operating costs. Those intended results can only be achieved if the related energy efficiency projects are well-conceived and well-implemented. A project set up or implemented in such a way can reduce to a very large extend the uncertainties and risks related to the achievement of energy savings and user's requirements as well as the uncertainties surrounding the investment cost and future operation and maintenance costs.

An early indication of the quality of design, implementation and envisaged operation of the energy efficiency project and of the possible risks associated with the resulting quality can be assessed by carrying out a due diligence.

This document provides an approach for (i) project quality assessment based on a desktop due diligence methodology, which in this document is being applied to the demo-case buildings in Italy and Spain, and for (ii) input data quality assurance related to the EEnvest approach of technical and financial risk assessment and multiple-benefits analysis.

Firstly, the desktop due diligence methodology consists of a desktop due-diligence questionnaire, which needs to be answered by the project owners, and a related scoring methodology, providing an indication of the probability that the energy efficiency project will achieve its objectives in terms of energy savings, expected investment cost, expected amounts for operation and maintenance costs and envisaged user's requirements. The desktop due diligence methodology has been developed in the form of an excel file.

Secondly, the approach for input data quality assurance consists of recommendations, suggestions and guidelines on what kind of data and how data need to be collected, elaborated and adjusted and what needs to be in place to assure high quality input data in the framework of the EEnvest methodology. The provided approach for input data quality assurance is at the same time an approach to (the preparation of) the execution of a due diligence as per the EEnvest methodology.

2 DESCRIPTION OF THE ENERGY EFFICIENCY RENOVATION STRATEGY OF THE DEMO CASE BUILDINGS

The two demo-case buildings (pilots) participating in the EEnvest project are located in Rome, Italy and Olot, Spain. As can be observed from the following comparison (Table 1) the building size is very different. In Italy 46000 m² will be renovated, in Spain 400 m2. Therefore, their energy efficiency renovation project is different in size of budget and in Spain higher energy savings are expected for a much smaller budget.

Table 1. Demo-cases highlights

	Rome, Italy	**Olot, Spain**
Building size	46.000 m² (24.470 m² heated)	400 m²
Floors	10 (8 floors above ground)	5 (4 floors above ground)
Energy consumption (Yearly)	€ 470.528	€ 12.569
Energy Renovation type	Technical installations	Deep renovation
Energy Conservation Measures	HVAC, Relighting, PV-system	HVAC, Relighting, PV-system, building envelope insulation, windows
Energy savings ambition	37%	97%
Investment Cost	€ 1.409.000	€ 250.000
Renovation cost/m²	+/- €60	+/- €625
Sustainability criteria	LEED certification, LEED EB: O&M	Inspired by UN's Sustainable Development Goals 7,11 and 12

Indeed, even if the energy renovation project of the Italian demo-case building can be qualified of a mid-sized project (< €1.500.000), it will only focus on the energy retrofit of the technical installations with an ambition of 37% energy savings. At the Spanish demo-case building, a rather small energy efficiency project (< €500.000) will allow a deep renovation of the building, including ECM on the technical installations and building envelope, and much higher energy savings of 97% are expected.

Both demo-case buildings have considered sustainability criteria to design the renovation projects. This chapter describes the energy efficiency renovation strategy defined in 2019 by for both demo-case buildings and executed in the course of 2020.

2.1 ITALIAN DEMO-CASE ROME, ITALY

The Italian demo-case building is the headquarters of International Fund for Agricultural Development (IFAD), an international financial institution and specialized United Nations agency that works to address poverty and hunger in rural areas of developing countries.

Figure 1. IFAD headquarters. Copyright: PRELIOS INTEGRA s.p.a

The IFAD building is located in Via Paolo di Dono 44 in Rome and it is managed by **Prelios SGR**. The office building was built in 2001, for a total gross surface area of more than 46,000 m^2. It is composed of ten floors, eight above-ground and two below-ground storeys. The net heating area is about 24,470 m^2 with a net heating volume of 97,048 m^3.

In 2010, the building was the first building to achieve the Leadership in Energy and Environmental Design certification for Existing Buildings: Operations and Maintenance (LEED EB:O&M).

In 2015, the IFAD building was the first Italian building and the first United Nations (UN) entity to become LEED certified, and it achieved the Platinum level, the highest level of LEED certification awarded by the United States Green Building Council (USGBC)[2].

LEED is a green building certification system that aims to reduce buildings impacts improving the energy performance the energy and water savings, the indoor environmental quality and final impacts promoting renewable and clean energy. The LEED system is based on a standard framework for validating, verifying and measuring of the design, construction, operations and maintenance solutions.

The IFAD building baseline energy consumption and building managing costs before the renovation (in 2017) amount to a bit more than 780,000 per year, including (see Table 2):

- **The natural gas consumption** for thermal energy, about 1.5M kWh/year, with relative cost of about 50,000 € (with a price of natural gas of 0.03 €/kWh)
- **The electric consumption,** about 3.2M kWh/year, with relative costs of about 420,000 € (considering the electric price of 0.13 €/kWh)
- **The operation and maintenance (O&M) cost** of the whole building, about 316,000 €/year (this data includes the costs of maintenance contracts of the building construction, thermal and electric systems, operational and replaced and substitution of the materials or components).

Table 2. IFAD building baseline energy consumption and costs before the renovation

BASELINE		
	ENERGY CONSUMPTION*	COSTS
Natural gas	1,468,243.00 kWh/a	49,920.26 €
Electricity	3,286,000.00 kWh/a	420,608.00 €
Energy consumption total. annual		**470,528.26 €**
O&M cost (annual) [3]		316.162,61 €
Total. Annual (Energy consumption + O&M)		**786.690,87 €**
* *average annual energy consumption of natural gas/electricity of the last 3 years (2016-2019). For electric energy, in case of existing renewable energy plants (i.e., PV) or cogeneration plants, it only considers the energy bought from the grid and not self-consumption.*		
****Total cost of maintenance: contracts + operations + replaced/substituted materials*		

In 2019, considering these energy consumptions, IFAD and Prelios SGR decided to renovate its building with the support of Prelios Integra SpA. A deep energy audit on the energy consumption of the whole building was conducted. The annual amount of the energy costs was about 470,000 €/year, divided between 11% for natural gas and 89% for electric demand, Figure 3. Motivated by the necessity to reduce the electric consumption, it was planned, and later realized, to improve the energy performance of the technical system. However, because it was renovated in 2015, the building envelope, in good condition was excluded from the energetic renovation.

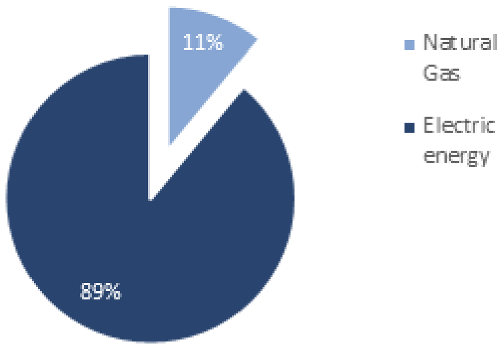

Figure 2. IFAD building, energy consumption before the renovation.

The proposed renovation strategy (see Table 3) aimed to increase the energy performance and to produce electric energy as much as possible. For the heating generation system, the gas boiler was substituted with the installation of a new co-generator (a system able to produce thermal and electric energy from the natural gas) and a photovoltaic system was installed. The mechanical air ventilation system was substituted with a better performing system using the multi-purpose air-conditioning system, and the lighting system was replaced with LED technology.

Table 3. Renovation measure of the IFAD office building.

BUILDING SERVICES		Costs
Heating System	Heat Pump (water)	190,000.00 €
Distribution system	Completed of pipes, fittings/valves/circulators/expansion vessel	37,000.00 €
Mechanical ventilation system (VMC)	VMC (Air handler/ Ventilation duct/Built-in components/Outlets/diffuser)	112,500.00 €
Lights type	Low power consumption lights, LED	403,787.00 €

Building Energy Management System (BEMS)	BEMS project by an expert certified UNI-EN 15232 Building automation system of: - Lighting - Thermal system (heating and cooling) - Monitoring system of energy consumption	190,000.00 €
Photovoltaic system	Production: 43,200 kWh/y PV Installed:38 kWp	156,731.00 €
Other costs for the projects, management, experts, administrative procedures, etc.		215,991.48 €
Total investment, (VAT excluded)		**1.306.009,48**

The energy renovation project aims to achieve a reduction of about 37% of the energy consumption of the building from 2019 to 2021.

In Table 4 are reported the energy consumption and relative costs, estimated after the renovation project. The natural gas demand increases from 1,468,243 kWh/a to 1,890,243 kWh/a after the renovation because the co-generator system implemented used natural gas to produce thermal and electric energy. On the contrary, the electric consumption (as electricity delivered form the grid) is reduced of 55%, passing from 3,286,000 kWh/a to 1,806,000 kWh/a after the renovation. After the renovation, the IFAD energy cost was estimated to be 295,436.26 €, divided between 22% of natural gas, and 78% of electric energy. About operation and maintenance cost (O&M), including contracts, operations, replacement materials, they are not expected to vary significantly after the renovation, thus the same amount is considered.

Table 4. IFAD building post-renovation energy consumption and costs.

IFAD building consumption and costs after the renovation		
	ENERGY CONSUMPTION*	COSTS
Natural gas	1,890,243 kWh/a	64,268.26 €
Electricity	1,806,000 kWh/a	231,168.00 €
Energy consumption total. annual		**295,436.26 €**
O&M cost (annual) [3]		316,162.61 €
Total. Annual (Energy consumption + O&M)		**611,598.87 €**
* *Expected annual energy consumption after the renovation*		
***Total cost of maintenance: contracts + operations + replaced/substituted materials*		

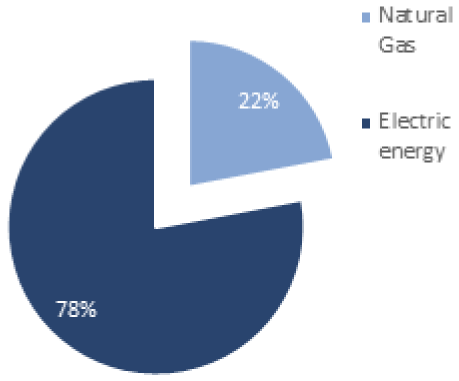

Figure 3. IFAD building, energy consumption after the renovation

According to the technical and financial indicators reported in Table 5, the renovation strategy successfully achieves the expected results in term of energy savings, with an attractive payback time of the investment of 7.46 years.

Table 5. Energy performance results of the renovation of the IFAD building

Building name	City	Net heating area	Energy consumption costs before the renovation (thermal and electric)	Planned energy consumption costs after the renovation (thermal and electric)	Costs saving due energy saving	Energy saving	Investment	Payback time without technical risks
		m2	€	€	€	%	€	year
IFAD	Roma, IT	24,470	470,528.26	295,436.26	175,092.00	37%	1,306,009.48	7.46

At the end of the renovation the LEED certificate was updated, achieving the Platinum level with 90 points – 2021, the maximum level of the LEED certification.

2.2 Spanish Demo-case, Olot, Spain

The Spanish pilot project is located in the city of Olot, Catalonia. It's an historical building constructed prior to 1883, which is the date of the first available data of the building.

The building is located on the very first street in the city of Olot and thus it was one of the first structures with more than one floor in the area. The construction works leveraged on the available resources of Olot's surroundings, such as solid stone, volcanic stone, volcanic sand layer and hydraulic tiles. Furthermore, the first floors had religious imagery with Olot's saints, thus acknowledging the historical background of the building.

In respect of the infrastructure, the building has a total of four floors (underground level plus 4 floors) and has approximately 400 m2. Given the fact that the building was built before 1883, it has very low sustainability criteria. Moreover, the building was inhabited since 2008 and in some cases, illegally occupied and in very bad condition. Figure 4 showcases the Spanish demo-case.

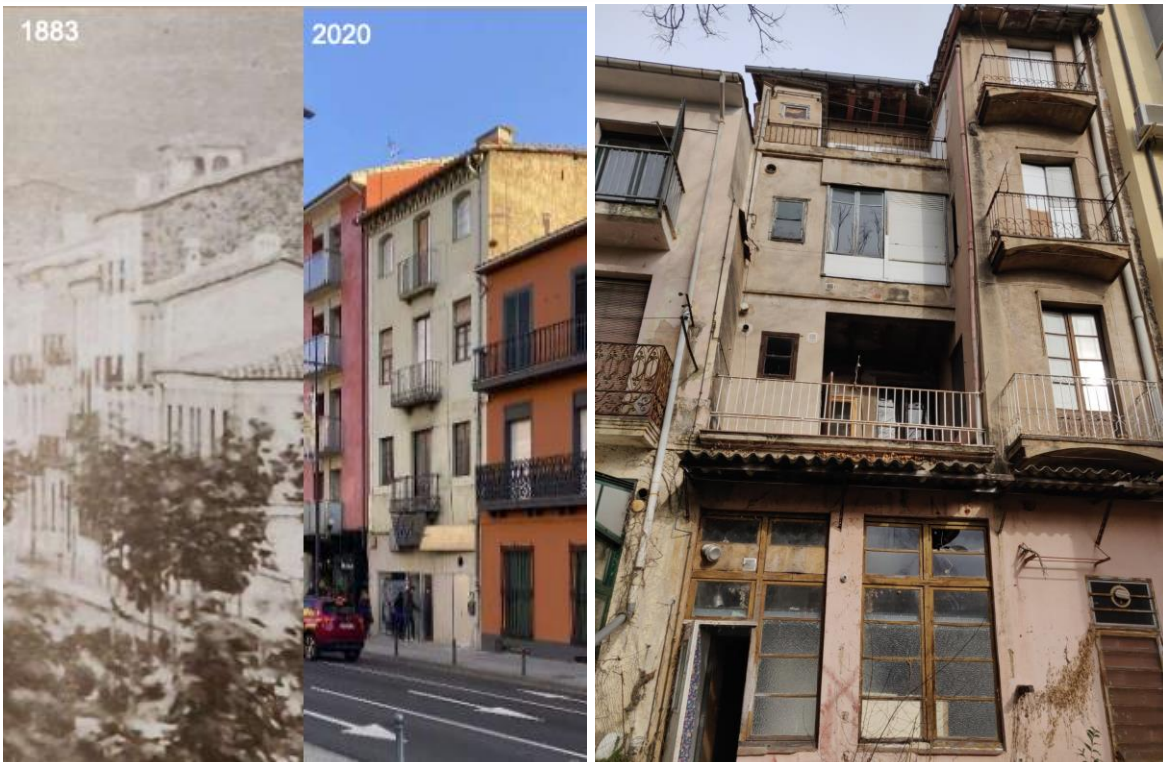

Figure 4. Pictures of the demo case facades, main street façade evolution from 1883 to 2020 (left), back street view at the beginning of the renovation project (right)

Prior to the renovation project, the energy performance of the building in 2013 was the lowest, scoring a letter G. This is better showcased in Figures 5 and 6 below.

Figure 5. Energy Performance Label prior to renovation

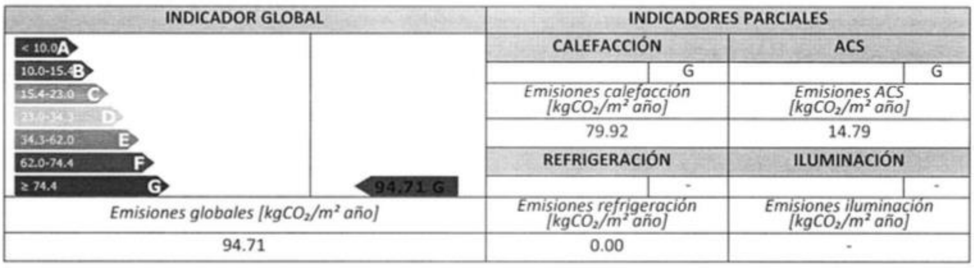

Figure 6. Energy Performance Label prior to renovation

Given the context of the historical building, the baseline energy consumption and costs before the project amount to a bit more than 12.500 € per year and include only electricity, as presented in Table 6 below.

Table 6. Mulleras building baseline energy consumption and costs before the renovation.

BASELINE		
	ENERGY CONSUMPTION*	COSTS
Natural gas	NA	NA
Electricity	79.117,00 kWh/a	12.658,72 €
Energy consumption total. annual	**79.117,00** kWh/a	**12.658,72** €
O&M cost [3]		
Total. Annual (Energy consumption + O&M)		**12.658,72** €
* *average annual energy consumption of natural gas/electricity of the last 3 years. For electric energy, in case of existing renewable energy plants (i.e., PV) or cogeneration plants, it only considers the energy bought from the grid and not self-consumption.*		
***Total cost of maintenance: contracts + operations + replaced/substituted materials*		

Given the characteristics of the Spanish demo-case, it's evident that the renovation work not only entails shallow energy efficiency, but rather a deep energy retrofit aimed at making the building habitable again whilst respecting the historical heritage of being one of the very first buildings of Olot.

The renovation strategy was designed by **FemNucli,** a private socially responsible investment company, which seeks to act in the recovery of cities, giving life back to historic, forgotten or impoverished neighbourhoods so that they are the nucleus of sustainable cities and healthy communities.

FemNucli's core values are aligned with environmental and social principles and thus all partners and stakeholders ought to share the same vision and values. Further, FemNucli defines as a low-profit and low-risk company, prioritizing social and environmental wellbeing over maximising financial returns while attracting impact investors.

The company's *modus operandi* is rather straightforward and consists of three main steps. First, they search for historical and inhabited buildings located in the middle of cities, and either buy or agree the assignment of these "left-behind" building types. Second, the company invests and undertakes deep renovation projects, prioritizing as much as possible the original architecture, design and history of the building. The outcome of the retrofit works is a modern, energy efficient, comfortable and sustainable building that promotes community life with shared values amongst tenants. This leads to the third and last step, which is to rent the individual apartments (I.e., single-family) to tenants that are aligned with FemNucli's values. The match between tenant's and FemNucli's values is a prioritized above everything.

The Spanish Demo-Case is called **Nucli01** and it's FemNucli's first project.

The renovation strategy of the Nucli01 project is holistic and it encompasses Sustainability in a broad sense, which is better represented in four dimensions. Three of them are the most common for this project type: Economic, Environmental and Societal. However, FemNucli goes a step beyond and incorporates a fourth dimension: Cultural.

FemNucli has a low-profit and low-risk profile. Therefore, an economic success means ensuring the viability of the project for the promoter and a fair rent for the tenants after renovation. From an environmental point of view, the building will be energy efficient with the aim to reach an “A” certification level, and will also recycle natural resources such as rain water and materials available in the region. In respect of the social aspect, the building will have spaces and services shared between the neighbours creating a feeling of community and co-responsibility, whilst improving the urban environment of the city centre. All tenants should share the same values and thus willingness to live in a small but yet sustainable community. Finally, the cultural dimension is brought through the fact that the renovation strategy will respect and reuse the materials and design from the original construction as much as possible, showing that buildings can be renovated respecting their original design and the history of the infrastructure itself.

In order to materialize the aforementioned dimensions, Nucli01 incorporates and promotes some of the Sustainable Development Goals, as presented below:

- Improve access to housing (goal 11.1)
- Inclusive and sustainable urbanization (goal 11.3)
- Safeguard cultural heritage (goal 11.4)
- Reduce the negative per capita environmental impact of cities (goal 11.6)
- Significantly increase the share of renewable energy (goal 7.2)
- Doubling the global rate of improvement in energy efficiency (goal 7.3)
- Achieve sustainable management and efficient use of natural resources (goal 12.2)
- Significantly reduce waste generation through prevention, reduction, recycling and reuse activities (goal 12.5)

Figure 7. Sustainable Development Goals promoted by the Spanish demo-case

In respect of the renovation works, cutting-edge design and innovation were the drivers for choosing the most suitable renovation measures for the project.

Some quick facts from the project are presented below and technical metrics and costs are shown in Tables below:

- Nucli01 will result in 5 fully renovated single-family apartments (4 for rent and 1 private)
- Overall budget for the renovation - approximately € 250,000
- Start of the works Q2 2020, end Q2 2021
- Financing structure of the project: 50% equity and 50% debt
- Innovative renovation measures
    - Centralized and shared sources of light, water and communication systems
    - Solar elevator
    - Rear façade of wood covered with solar panels

- Rainwater storage and usage systems

Table 7. Renovation measure of the Mulleras office building.

BUILDING ENVELOPE		Costs
Pitched roof - Ceiling next to air (outside)	External insulation	500,00 €
	Internal insulation	1.700 €
Floor next to ground (outside)	new insulation	310,00 €
	Ext.Wall - External cladding (insulation, glue and plaster)	130.000,00 €
	Ext.Wall - Internal insulation (insulation, glue and plaster)	12.000,00 €
	Ext.Wall - Window façade system - Curtain wall (frame, insulated glass unit, gasket system, anchoring system)	12.500,00 €
Windows	**Wall windows**	21.460,0 €
	Roof windows	1.150,00 €
Shading Systems	Internal Shading Systems	1.890,00 €
BUILDING SERVICES		
Heating System	Heat Pump (water)	14.000,00 €
	Heat Pump (air)	2.000,00 €
Mechanical ventilation system (VMC)	VMC (Air handler/ Ventilation duct/Built-in components/Outlets/diffuser)	5.450,00 €
Lights type	Low power consumption lights, LED	1.200,00 €
Photovoltaic system	Production: 6,600 kWh/y	10.752,00 €
IT installations		3.000,00 €
Other costs for the projects, management, experts, administrative procedures, etc.		32.088,00 €
Tot. investment, (VAT excluded)		**250.000,00**

Table 8. Mulleras building post-renovation energy consumption and costs.

IFAD building consumption and costs after the renovation		
	ENERGY CONSUMPTION*	COSTS
Natural gas	NA	NA
Electricity	2.559,60 kWh	409,54 €
Energy consumption total. annual	2.559,60 kWh	409,54 €
O&M cost **		
Total. Annual (Energy consumption + O&M)		**409,54 €**
***** *Expected annual energy consumption after the renovation*		
*******Total cost of maintenance: contracts + operations + replaced/substituted materials*		

According to the technical and financial indicators reported in Table 9, the renovation strategy successfully achieves considerable results in term of energy savings (-97%), with a payback time of the investment of 20,41 years.

Table 9. Energy performance results of the renovation of Mulleras

Building name	City	Net heating area	Energy consumption costs before the renovation (thermal and electric)	Planned energy consumption costs after the renovation (thermal and electric)	Costs saving due energy saving	Energy saving	Investment	Static Payback time (without technical risks)
		m2	€	€	€	%	€	year
Fem Nucli	Olot, SP	347,34	12.658,72	409,54	12.249,18	97%	250.000,00	20,41

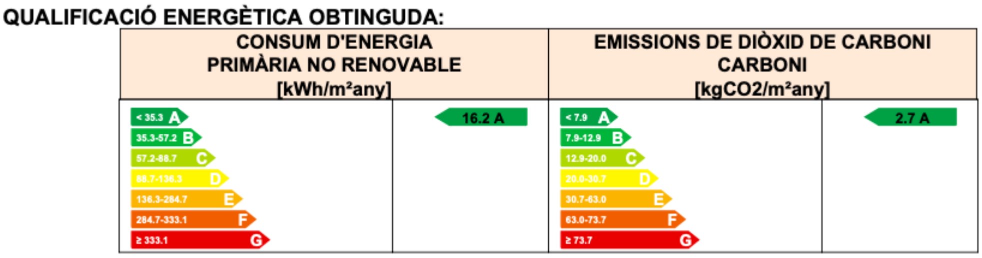

Figure 8. Obtained Energy Performance Label

FemNucli01 is now fully habitable and it enjoys an energy performance certificate of A (2021). It’s important to highlight the difference between the ex-ante and ex-post renovation scenarios, which showcase a dual strategy that prioritizes energy efficiency and habitability, whilst respecting the cultural heritage of the building (see picture of the building indoor space).

FemNucli’s business model is designed for scalability across the region by incorporating innovating financing solutions that come mainly from financing entities seeking ESG criteria, rather than purely financial aspects. Figures 9. and 10. below present the building after the renovation project.

Figure 9 . Façade of the building after renovation

Figure 10 Interior design after the renovation project

3 DESKTOP DUE DILIGENCE ON THE DEMO-CASE BUILDINGS

The intended results of the energy renovation strategies of the two demo-case buildings, as described in the previous chapter, can only be achieved if the respective energy renovation projects have been set-up or implemented in such a way that those intended results can actually be achieved throughout the lifecycle of the project.

3.1 ENERGY EFFICIENCY PROJECTS SPECIFICITIES

The lifecycle of an energy efficiency project typically encompasses two main phases. Firstly, a design phase of the Energy Conservation Measures (ECM), often also referred to as the energy efficiency assets, an implementation phase of the ECM. Secondly, an operations phase during which the energy efficiency assets are being operated and maintained in order to secure their optimal performance and ability to achieve the intended energy savings and other project requirements referred to as Multiple benefits (MBs) within EEnvest. These MBs could be, for example, reduction of CO_2 emissions, envisaged comfort levels and/or indoor air quality improvements.
Poorly designed and/or implemented energy efficiency projects might miss their intended purpose, not only from a financial point of view but also form a social point of view. From a financial point of view badly implemented projects might result in less than foreseen energy cost savings, more than foreseen investment expenses or more than foreseen operations and maintenance costs during the lifecycle of the energy efficiency project. From a social point of view these badly implemented projects might result in comfort levels or indoor air quality requirements not being attained, directly affecting the ultimate users or occupants of the building or space subject to the energy efficiency renovation, or environmental goals being missed as a result of less CO_2 savings than intended.

Well-conceived and well-implemented energy efficiency projects, at the contrary, can reduce to a very large extend the uncertainties and risks related to the achievement of energy savings and user's requirements as well as the uncertainties surrounding the investment cost and future operation and maintenance costs. These high-quality projects typically take into account high or the highest standards, quality criteria and best practices when conceived, implemented and operated, evidenced by the existence of, for example, tools, documentation, procedures and activities following accepted standards and norms and best practices.

The existence or absence of these elements allow to have an idea of the quality of implementation and ongoing operation of the energy efficiency project and the possible risks associated with the resulting quality of implementation and operation. Thus, an evaluation from a qualitative point of view can result in the assessment of the quality and thus of the risks associated to the energy efficiency project. Such an assessment can be done by carrying out a due diligence.

3.2 ENERGY EFFICIENCY DUE DILIGENCE

Due diligence normally takes place during the phase preliminary to the implementation and certainly preliminary to the operation of the implemented EECM. The principal objective of an Energy Efficiency due diligence is to try to assess whether all required elements have been put in place or are going to be put in place to assure a well-conceived and well-implemented energy efficiency project.

The due diligence carried out on EEnvest's demo-case buildings in Italy and Spain takes the form of a desktop due diligence, based on a specifically developed questionnaire that needs to be answered by the demo-cases. The due diligence is not intended to provide any official certification as it has been developed for the benefit of the demo-cases, and by extension to Energy Efficiency project owners, based on an honest and truthful judgement of the questions. The desktop due-diligence questionnaire

(DDDQ) queries whether the relevant elements mentioned earlier in paragraph 3.1 are in place or not or are intended to be in place or not, and as such, allows to give an indication of the quality of design, implementation and ongoing operation of the energy efficiency project and the possible risks associated with the resulting quality. The DDDQ being a self-assessment tool, no control, verification nor testing or physical assessment of the answers will be performed.

In order to be able to define the elements that, following best practices, need to be in place in order to ensure a well-conceived and well-implemented energy efficiency project inspiration has been sought in some existing European projects and models dealing with the quality of implementation of energy efficiency projects. These sources of inspiration are being described and discussed in the next chapter.

The quality of design, implementation and ongoing operation of the energy efficiency project and the possible risks associated with the resulting quality is being objectivised based on a scoring and labelling methodology developed within the framework of WP6 and described further on. The scoring methodology basically allocates a number of points to the different required elements, and based on the obtained scores, it provides an indication of the chance that the energy efficiency project will achieve its objectives in terms of energy savings, expected investment cost, expected amounts for operation and maintenance costs and envisaged user's requirements.

The DDDQ and the scoring methodology are being put into practice on the Italian and Spanish demo-case building as described in Chapter 3.5. This Chapter analysis the responses of the two demo-cases to the DDDQ, applies and interprets the obtained scorings and finally provides recommendations to the demo-cases on possible improvements.

3.3 EXAMPLES OF QUALITY APPROACH TO ENERGY EFFICIENCY PROJECTS

One energy efficiency procurement model and two identified European Projects focusing on the quality of implementation of energy efficiency projects, namely smartEPC (developed by Energinvest), and the Horizon2020 projects QualitEE and Investor Confidence Project ICP have inspired the EEnvest desktop due diligence.

Although different in approach, these sources have in common that they define requirements (depending on the source these are referred to as project requirements, quality assessment criteria, protocols or specifications) and related guidance regarding how these requirements can or should be met in order to ensure a highly qualitative implementation and operation of an energy efficiency project.

The energy efficiency procurement model and the two identified European Projects are being presented hereafter and are further briefly described in Annex A.

SmartEPC, Energinvest

SmartEPC is an innovative Energy Performance Contract (EPC) model, developed initially in Belgium by Energinvest and some partners for the Federal Government's public buildings and currently applied in other EPC projects, still mainly in Belgium. It is a modular procurement model, based on the Maintenance and Energy Performance Contract (M-EPC) model. M-EPC is a comprehensive maintenance concept, extending well beyond the merely installation and maintenance of the planned ECM (often called the EPC assets) to include all energy related equipment (e.g., non-renovated boiler rooms, non-upgraded lighting) or even non-energy related equipment maintenance (sanitary installations, elevators, fire equipment, access control, etc.) and possibly building envelope related items, like doors and windows, roofs, etc. M-EPC can be performance based when it is based on the NEN2767 standard (NEN, 2019) widely used in the Netherlands and Belgium. Rather than using lengthy specifications for maintenance it uses condition scores to determine the quality of installations before the contract and the result of quality maintenance during and at the end of the contract.

The core of smartEPC is based on an extensive table defining all applicable **Project Requirements which are being grouped into eight Themes**. These Project Requirements encompass all the details of the envisaged energy efficiency project, providing a clear guidance related to the defined requirements, instruments and tools, expectations, penalties and bonusses, and quality management.

QualitEE project, EU H2020 project

The QualitEE project aims to increase investment in energy efficiency services in the building sector within the EU and improve trust in service providers. To achieve these aims, quality assessment criteria and business cases for quality assurance schemes have been developed. It focuses on the following types of energy efficiency services: Energy Performance Contracting, Energy Supply Contracting, Operational Contracting and Integrated Energy Contracting.

QualitEE developed the following three tools:

- Guidelines of European Technical Quality Criteria for Energy Efficiency Services
- Financial Guidelines for Energy Efficiency Services
- Procurement Handbook for Energy Efficiency Services

Specifically, the **Guidelines of European Technical Quality Criteria for Energy Efficiency Services** is an interesting tool providing insight into framework conditions and key activities that secure the success of a project. The aim of these Guidelines is to establish a common understanding between specific stakeholders of a project for the assessment of the quality and thus of the risks of energy efficiency projects. The assessment of quality and the related risks is also the aim of the desktop based due diligence questionnaire developed within the EEnvest project. By defining and operationalising technical, economic, communicational and other relevant criteria, the so-called “Quality criteria”, the Guidelines support a comprehensive evaluation of the quality of energy efficiency services. The criteria set in the Guidelines are partly based on “preliminary quality criteria for energy efficiency services” developed for the Austrian market within the Transparense project.

As already highlighted, and contrary to the intention of the QualitEE project, the desktop based due diligence questionnaire or checklist developed within the EEnvest project is on a self-assessment basis, hence there will be no control, verification nor testing or physical assessment of the answers as this desktop due-diligence is there to the benefit of the project owners and is not intended to provide any official certification.

Investor Confidence Project, (ICP) EU H2020 project

The Investor Confidence Project (ICP) wants to “standardize the way energy efficiency projects are developed, documented and measured in order to facilitate private investments and enable project aggregation” (ICP,2020). According to their website the standardization methodology they have developed, “which follows best practice and involves independent verification, is essential to increasing transparency, consistency and trust-worthiness of energy efficiency projects and therefore builds investors' confidence in this market.”

One of the most visible outcomes of ICP is their Investor Ready Energy Efficiency™ Certification for energy efficiency projects. This certification can be granted to projects that are developed following the ICP Protocols and are independently verified by an ICP Quality Assurance professional.

ICP has developed nine **Energy Performance Protocols** for Europe defining a standardised road map of best practices for originating energy efficiency projects following the ICP Project Lifecycle. These protocols cover tertiary and apartment block building energy efficiency projects, complex and simple industry projects and also street lighting projects. ICP has also developed the **ICP Project Development Specification**. This specification brings the details of an energy efficiency project into focus, providing a clear direction with regards to requirements, tools, expectations and quality management. The Project Development Specification intends to support the elements, procedures and documentation requirements described in detail in the above mentioned nine Energy Performance

Protocols and is thus a very interesting document for the purpose of establishing a desktop based due diligence questionnaire.

3.4 THE DESKTOP DUE DILIGENCE METHODOLOGY

3.4.1 Introduction

The desktop due diligence methodology aims at providing an early indication of the quality of design, implementation and ongoing operation of the energy efficiency project and of the possible risks associated with the resulting quality. The indication of quality is based on the answering of a specifically developed Desktop Due Diligence Questionnaire consisting of **six Themes** covering the design, implementation and ongoing operation of the energy efficiency project and provides an indication of the probability that the energy efficiency project will achieve its objectives in terms of energy savings, expected investment cost, expected amounts for operation and maintenance costs and envisaged user's requirements.

For each of the six Themes of the DDDQ we defined the items or elements, which can be standards, activities, documentation, tools, best practices, approaches or procedures, that need to be in place in order to assure a well-conceived and well-implemented energy efficiency project.

By defining these elements that had to be in place there was the need of being as concise though as complete as possible in order to meet three basic requirements set forth when conceiving the Desktop Due Diligence questionnaire:

- The time required to fill-out the questionnaire had to be limited to **less than one hour**. The assumption here is that the respondent would be a person knowledgeable of the energy efficiency project, i.e., having a good knowledge of the design, implementation and operational elements of the energy efficiency project e.g., envisaged energy conservation measures, energy savings calculation tools, maintenance and operational elements, monitoring tools, measurement and verification approach, etc...
- Almost all questions (and if possible, all questions) would require a "**Yes", "No" or "Not Applicable" answer** and, based on these answers, feedback should be provided on risk and quality
- There would be **no control, verification nor testing or physical assessment** of the answers as this desktop due-diligence would be developed for the benefit of the project owners based on an honest and truthful judgement. As a result, the desktop-based questionnaire was not intended to provide any official certification nor provide any certification of quality assurance of any of the stages of the energy efficiency project: conception, implementation and operation.

The existence or absence of those defined elements allow to have an idea of the quality of implementation and ongoing operation of the energy efficiency project and the possible risks associated with the resulting quality of implementation and operation. The better an energy efficiency project has been conceived and set-up, evidenced by the existence of the elements referred to in the different Themes, the more the risks and uncertainties surrounding the achievement of the energy efficiency savings, the size of the investment cost, the expected amounts for operation and maintenance costs and the envisaged user's requirements (e.g., comfort, indoor air quality, etc...) can be mitigated.

The quality of implementation and ongoing operation of the energy efficiency project has been objectivised in a scoring and labelling methodology described in detail further on.

Firstly, the **scoring methodology** allocates a weight to the different Themes based on the relative importance or impact that these Themes can have on the results of an energy efficiency project. Within the different Themes the scoring methodology basically allocates a number of points or a score to the different required elements. In the ideal circumstance, i.e., in the case that all required elements are in place, the resulting sum of the points equals the weight associated to the individual Theme. The sum of the scores of the individual Themes results in a global score. The logic behind the methodology is that the higher the obtained scores within the different Themes the higher the global score will be, and consequently the higher the probability will be that the energy efficiency project will achieve its objectives.

Secondly, the obtained scores for the different Themes and the Global score, obviously resulting from the answers to the DDDQ, are then incorporated in a **five-level probability scale** and depending on the range are given a colour label. The five associated colour labels will indicate whether the different Themes and the global project have a very high probability, high probability, reasonable probability, low probability or very low probability to achieve their specific objectives. The colour labels will also feature a short description, the purpose being to provide a brief explanation and indication of the quality of conception and set up of the project as a whole (Gobal score) and of the six different Themes in particular.

3.4.2 The Desktop Due Diligence Questionnaire (DDDQ)

The core of the desktop due-diligence is the Desktop Due-diligence Questionnaire (DDDQ). The DDDQ, which has been developed as a worksheet with relevant questions, is structured around the following six Themes covering the typical processes and activities that should be taken into consideration when implementing a typical energy efficiency project, from its initial conception phase to the end of the project:

Theme 1: Design of ECM and energy savings calculations
Theme 2: Implementation of ECM (Energy Efficiency Assets)
Theme 3: Maintenance and operation of the Energy Efficiency Assets
Theme 4: Monitoring of the Energy Efficiency Assets and their energy consumption
Theme 5: Measurement and verification of the energy savings
Theme 6: Communication with and training (awareness) of users and/or occupants

It is important to highlight that the project activities of the different Themes have some kind of sequence of execution because some preceding activities have an effect on subsequent activities as can be seen on the following simplified figure.

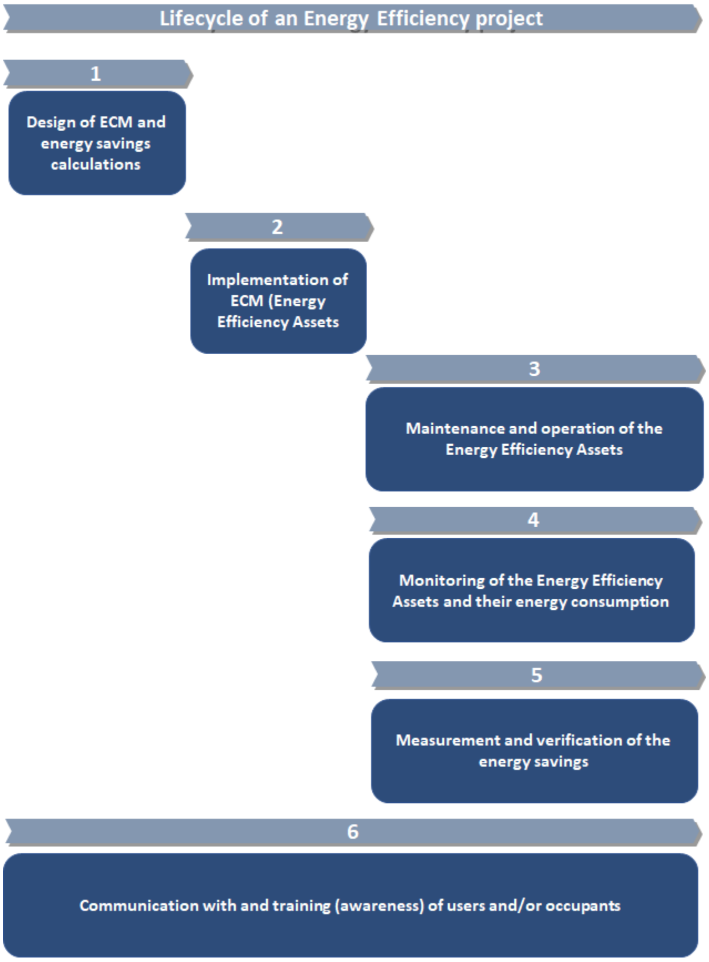

Figure 11 Simplified sequence of the execution of an Energy Efficiency project

For instance, the activities of Theme 2: Implementation of the Energy Conservation Measures are subsequent to the activities of Theme 1: Design of ECM and energy savings calculations and precede the Themes 3, 4, 5 and 6, whereas Themes 3, 4, 5 and 6 are being executed in parallel during the operational phase of the energy efficiency project. Theme 6, which is focused on the ultimate users or the beneficiaries of the Energy Efficiency Assets, ideally starts at the beginning of the project to ensure that these ultimate users are being adequately considered throughout the full lifecycle of the project.

The following Figure 12. provides an overview per defined Theme of the elements (standards, activities, documentation, tools, best practices, approaches or procedures) that need to be taken into consideration in a well-conceived and well-implemented energy efficiency project.

1. Design of ECM and energy savings calculations

- Energy audit
- Energy consumption baseline
- Energy savings modelling and calculations
- Interdependency calculations in case of multiple ECM

2. Implementation of ECM (Energy Efficiency Assets)

- Independency and expertise of the implementing parties (project co-ordinators, installers, contractors)
- Installation or implementation plan
- Roles and responsibilities of the installers and compliance requirements
- Operational performance verification
- Acceptance process and training of operators

3. Maintenance and operation of the Energy Efficiency Assets

- Maintenance service contract
- Independency and expertise of maintenance contractor
- Maintenance plan
- Roles and responsibilities of the maintenance contractor
- Issue logging and escalation
- Malfunctioning and non-compliance

4. Monitoring of the Energy Efficiency Assets and their energy consumption

- Performance monitoring and tracking methodology
- Performance Indicators
- Monitoring and management tools
- Training and performance monitoring

5. Measurement and verification of the energy savings

- Measurement and verification approach
- Use of M&V protocols
- M&V expertise and certification

6. Communication with and training (awareness) of users and/or occupants

- Approach for collection, verification and implementation of users' requirements
- Information process on the implemented ECM
- Energy awareness program

Figure 12. Overview of the 6 Themes and their defined elements

The rationale for including the defined elements in the 6 different Themes as well as the resulting questions querying the existence or absence of these elements are being provided hereafter.

Theme 1: Design of ECM and energy savings calculations

The design of the ECM and the energy savings calculations happen at the very beginning of any energy efficiency project. In order to assess the energy savings potential of a project it is extremely important to conduct an energy audit. The energy audit provides insight into which ECM have what kind of energy savings potential and at which price (the investment amount). Not conducting an energy audit would mean relying on rules of thumb or rough estimates, increasing the risk of inaccurate calculations and wrong decision-making. This energy audit should be performed as much as possible by experienced energy auditors or energy specialist to ensure high quality of the audit.

Having an energy consumption baseline in place taking into consideration all elements and factors that influence the baseline calculation and using appropriate calculation tools and reporting is the basis for being able to calculate the potential energy savings as well as being able to measure the real savings after the implementation of the ECM.

Energy savings calculation and modelling can be a very complex activity requiring high expertise, not only requiring knowledge on the potential energy savings of individual ECMs but also on the interdependencies between the measures and their effect on e.g., heating and cooling demand.

Hence the following elements should be included in Theme 1:

- Energy audit
- Energy consumption baseline
- Energy savings modelling and calculations
- Interdependency calculations in case of multiple ECM

The resulting questions are the following:

1.		Has an Energy Audit been carried-out to define the energy efficiency savings potential of the project?
	1.a.	Has the Energy Audit been carried out by an independent and certified energy auditor following required national or international standards (e.g. EN 16247-1 or ISO 50002 (Energy Audits))?
	1.b.	Has the Energy Audit been carried out by in-house staff or third parties having considerable expertise with Energy Efficiency projects and/or Energy Conservation Measures?
	1.c.	Has the Energy Audit been carried out by in-house staff with some or little Energy Efficiency expertise?
2.		Has an Energy Consumption baseline (the reference baseline for future comparison) been calculated capturing the total energy use prior to deploying the ECM?
	2.a.	Did the Energy Consumption baseline calculation take into account all of the following : a.) the system boundaries (the component parts), b). the energy sources, c). a sufficiently long representative baseline period, d.) the impact of independent variables (e.g. weather, occupation, operational hours,...) and e.) setting of Energy Performance Indicators
	2.b.	Did the Energy Consumption baseline calculation take some or not all of the requirements a.) through e.) as enumerated in the previous question?
	2.c	Has a report/document been issued showing the details of the Energy Consumption baseline calculations carried out, assumptions made and underlying data used?
3.		Have the energy savings calculations related to the ECM been performed using a savings modeling tool officially recognised (by competent authorities) or well-reputed in the market (e.g. PHPP Passive House, BeOpt, eQuest, Openstudio/EnergyPlus, ResStock, RETScreen, HEED, etc.,...)
	3.a.	Has a dynamic modelling method/ tool been used?
	3.b.	Has a regression modelling method/tool been used?
	3.c.	Has a modelling method/tool been used different than dynamic modelling or regression?
4.		Have the savings calculations been performed by experienced modellers, preferably with required qualifications and/or certifications?
5.		Has a report been issued showing the ECM/savings modeling process including all modeling assumptions, modeling inputs and outputs and possible modeling errors and limitations?
6.		Has a report been issued listing all the ECM in detail (existing conditions, proposed renovation,...) preferably ranked based on their energy savings potential with their associated implementation cost (investment cost)?
7.		Does the project envisage only one ECM (e.g. HVAC retrofit) or does the project envisage multiple ECM (e.g. HVAC retrofit and relighting and/or other ECM).
	7a.	If multiple ECM have been envisaged is there clear evidence that calculations have taken into account interactions (interdependencies) between measures and their impact on heating and cooling loads (demand), e.g. efficient relighting renovation might increase heat demand.

Figure 13. DDD questions related to Theme 1

Theme 2: Implementation of ECM (Energy Efficiency Assets)

The objective of the questions related to this Theme is to assess whether the envisaged ECM are being implemented as agreed and intended during the design phase and whether these ECM perform as expected or intended.

The quality of implementation of the ECM and the related risks of ill-implemented and thus not well-functioning energy assets depends to a high degree on the expertise and know-how of the installers/contractors and the manner in which the implementation process has been defined and agreed upon. Though there is nothing wrong with the use of in-house staff or experts (they can be highly skilled and can have the required expertise) the use of 3rd party independent experts is preferred to avoid possible conflicts of interest. Furthermore, 3rd party independent experts are required to be unbiased in their approach and by the nature of their profession or business have highly specialised skills that are very difficult or very expensive to acquire by the project owner.

Defining roles and responsibilities, relationships with the installers/contractors, an adequate operational performance (commissioning) verification process, ECM acceptance evidence, technical instructions and/or operational information and finally operator's training on the installed energy efficiency assets are items that must be carefully set-up and executed before the operational phase of the energy efficiency project.

Therefore, the following elements should be inquired in this part of the Desktop Due Diligence questionnaire:

- Independency and expertise of the implementing parties (project co-ordinators, installers, contractors)
- Installation or implementation plan
- Roles and responsibilities of the installers and compliance requirements
- Operational performance verification
- Acceptance process and training of operators

The resulting questions are the following:

8.	Is there an overall 3rd party (Facilitator, independent engineer, architect,...) responsible for the co-ordination and the implementation of the Energy Conservation Measures?
8.a.	If not, has as an in-house co-ordinator with proven experience in Energy Efficiency projects been appointed to co-ordinate and oversee the implementation of the ECM?
9.	Have the installers (contractors) of the ECMs been assigned based on a bid process that is also taking into consideration quality criteria (proven expertise, past projects, certifications,...)?
10.	Has the appointment of the installers been influenced by other elements than quality and price (e.g. personal relationship, family, by reference,...)
11.	Is there a well defined installation plan of the ECM with implementation deadlines agreed with the contractor(s)?
12.	Has a process been put in place for the possible adjustment of the initially committed implementation deadlines?
13.	Does the contract with the installers (contractors) provide for penalties applicable in order to incentivise the installers not to exceed the installation deadlines?
14.	Does the contract with the installers (contractors) request compliance with technical standards relevant to the implementation of the ECM?
15.	Does the contract with the installers (contractors) provide for compliance with official permits relevant to the implementation of the ECM?
16.	Has an agreed process been defined on how the operational performance (also called commissioning) of the ECM are going to be verified?
17.	Is the verification methodology (visual inspection, sample spot measures, functional testing, performance testing,..) per ECM/group of ECMs been defined and agreed upon?
18.	Does the operational performance verification include verification of the necessary tools (e.g. meters, energy monitoring system,...) allowing collection and analysis of the performance of the Energy Efficiency Assets after installation?
19.	Is the operational performance verification being done or supervised by a qualified or experienced energy efficiency expert?
20.	Are there or will there be acceptance records evidencing formal acceptance by the client of the ECM implemented?
21.	Does the acceptance process include documentation of technical instructions and/or operational information (System or Operator's guide) related to the Energy Efficiency Assets in order to ensure their optimal functioning and performance during the operational phase?
22.	Does the acceptance process include training of users or operating staff on the impact of the EEA, their correct operation , detection of issues and possible remediaton?

Figure 14. DDD questions related to Theme 2

Theme 3: Maintenance and operation of the Energy Efficiency Assets

The purpose of the questions of this Theme is to assess whether the required elements are in place to allow an optimal maintenance and operation of the Energy Efficiency Assets. The required elements do not include monitoring requirements as these are dealt with separately under Theme 4: Monitoring of the Energy Efficiency Assets and their energy consumption.

The Maintenance and operation activity is about making sure that those ECM that need maintenance function optimally providing the energy performance of the energy assets as intended while assuring the agreed-upon building users' requirements (e.g., thermal comfort, indoor quality and ventilation requirements and visual comfort). An optimal maintenance and operation process combines preventive and proactive maintenance with corrective maintenance. Key components of a corrective maintenance relate to the existence of performance tracking tools, fault detection and diagnostic tools to detect performance issues, diagnosis of issues and identification of the related solutions but also timely remediation.

All these activities should normally be laid down in a maintenance plan including maintenance schedules and roles and responsibilities.

In analogy with Theme 2., the maintenance and operation activities can be serviced by in-house staff or experts as they could have similar technical skills and required expertise as specialised 3rd parties. But here, again, the use of 3rd party independent maintenance and operation specialists is preferred to avoid possible conflicts of interests or any possible biased or suboptimal maintenance approach as a result of the absence of any at-arms-length relationship.

Defining roles and responsibilities, agreeing on maintenance schedules, defining issues logging and escalation procedures, defining repair times, dealing with malfunctions and applicable penalties are requirements that need to be set-up adequately in order to ensure the optimal functioning of the energy assets.

As a consequence, the following elements are to be included in this Theme 3:

- Maintenance service contract
- Independency and expertise of maintenance contractor
- Maintenance plan
- Roles and responsibilities of the maintenance contractor
- Issue logging and escalation
- Malfunctioning and non-compliance

The resulting questions are the following:

23.	Does the project foresee a Maintenance services contract with a specialised 3rd party for those ECM that need maintanance in order to function optimally?
23.a.	Has the Maintenance contractor been procured based on a bid process that is also taking into consideration quality criteria (proven expertise, past project, certifications,...)
23.b.	Is there or will there be an agreed Maintentenace Plan with the contracted party clarifying the role and responsibilities of the parties including maintenance schedules
23.c.	Does the Maintenance agreement clarify the communciation between the parties including the issues logging procedure and the escalation process?
23.d.	Does the contract with the Maintenance Party deal with different types of malfunction (e.g. nomal, urgent, critical) and their required repair times in order to safeguard optimal functioning of the Energy Efficiency Assets
23.e.	Does the contract with the Maintenance Party provide for penalties for non-compliance with repair times and/or plans?
23.f.	Does the contract with the Maintenance Party provide for a system of penalties for repetitive or multiple malfunctions?
23.g.	Does the contract with the Maintenance Party provide for a system of recording malfunctions and repair lead times for future reconciliation and proof?
24.	If no maintenance services contract has been foreseen, is there a fomal internal maintenance plan based on the technical instructions and predictive maintenance requirements from the System or Operator's Guide ?
25.	If no maintenance services contract has been foreseen, is the maintenance plan executed by in-house expert technical staff with energy efficiency expertise or based on relevant qualifications or certifications?

Figure 15. DDD questions related to Theme 3

Theme 4: Monitoring of the Energy Efficiency Assets and their energy consumption

The elements in this Theme 4, and consequently the derived questions, focus on the monitoring process and monitoring tools that should be in place. The activity of performance monitoring, performance issue detection and, to a lesser extent, diagnosis of issues and identification of remediation solutions rely heavily on performance tracking tools.

Multiple tools can be deployed, such as equipment performance data trackers and/or fault detection and diagnostic tools. These tools can track data on a building level, on specific energy systems or end-uses (subsystems and equipment level) in intervals. These intervals can for example be 15-minutes or half hourly, hourly or daily or longer intervals. The collected energy and performance data from the data collections systems need to be analysed and assessed against savings expectations. This typically happens in Energy Management Systems. Energy Management Systems analyse the data, detect anomalies, underperformance or problems, provide reports and graphics of the energy performance of the building. This can happen in real time in line with the data collection intervals. Energy Management Systems usually don't detect the cause of the problems. The use of Building Management Systems which are based on trending and analysis of long-term patterns, averages and ranges that can identify abnormal changes in values can detect underlying problems of the operating system and thus operating performance. This performance monitoring needs manual triggering and processing whereas the use of automated fault detection and diagnostic tools automatically detect, isolate and identify (diagnosis) and evaluate faults (assessment of the fault's impact on system performance) based on fault detection algorithms.

All data analysed has only meaning if it can be compared with previously set performance goals and performance indicators. These key performance indicators must, of course, be meaningful and connected to the relevant energy efficiency assets as well as to the energy performance features of these energy efficiency assets. KPI can be set at building level, at energy system level (e.g., HVAC system) or even at equipment level (e.g., at heat pump level).

Finally, whether performance monitoring is being done in-house or by a specialised 3rd party, training of the operating staff responsible for the optimal operation of the energy efficiency assets on the use of the monitoring systems is paramount.

Therefore, the following elements should be included in the Desktop Due Diligence questionnaire:

- Performance monitoring and tracking methodology
- Performance Indicators
- Monitoring and management tools
- Training on performance monitoring

The resulting questions are the following:

26.	Does the project foresee monitoring of the Energy Efficiency Assets and the related energy consumption?
26.a.	Have key performance indicators (e.g. heating degree days, kWh consumed per building, kWh consumed per user, guaranteed energy savings,...) been selected and are these representative of the system operation and energy performance?
26.b	Is there a well defined methodology for tracking, analysing and assessing the performance of the Energy Efficiency Assets against expected savings and selected performance indicators?
26.c.	Does the performance monitoring include a data collection system for energy data collection (meters, submeters, gateway,...)?
26.d.	Does the performance monitoring include an Energy Management System allowing for the analysis and performance of the collected energy data?
26.e.	Does the performance monitoring include a Building Management System?
26.f.	Does the performance monitoring include automated fault detection and diagnostic tools?
26.g.	Does the training of operating staff responsible for the optimal operation of the Energy Efficiency Assets include specific training on the adequate use of the monitoring systems?

Figure 16. DDD questions related to Theme 4

Theme 5: Measurement and verification of the energy savings

This section queries the existence of a process of Measurement and Verification of the achieved energy savings as a result of the implementation of the Energy Conservation Measures. The objective of M&V, basically, is to compare the energy performance and use after the implementation of the ECM (i.e., the new energy consumption) with the energy consumption baseline defined under Theme 1: Design of ECM and energy savings calculations, the latter being the reference point, the energy consumption that would have been if no ECM had been implemented. These achieved savings need to be normalised in order to take into consideration factors that have influenced the energy savings and that are not a direct result of the implementation of the ECM. These influence factors result in adjustments to the consumption baseline and are often referred to as routine adjustments (relatively predictable such as building occupancy and weather conditions) or as non-routine adjustments (for instance, changes in opening hours or operating hours after a sudden event). In other words, the purpose of normalisation is to bring the calculations of the baseline energy performance and the achieved energy performance to the same set of conditions.

A well-conceived process of Measurement & Verification typically follows different steps which are being defined by ICP (ICP,2016), for instance, as follows: 1. Document baseline energy consumption, 2. Develop the M&V Plan, 3. Verify Operational Performance 4. Collect data, 5. Verify the savings and 6. Report results. Implementing a comprehensive or full-scale M&V approach (on whole facility) often comes with a price because of the complexity, required tools and required expertise and might be financially not feasible or not desirable for smaller projects. These smaller projects might rather benefit from a simplified M&V approach whereby the focus would be on individual measures backed up or complemented with additional controls or testing (e.g., blower-door-tests).

Calculating the required adjustments can be a very complex activity, requiring quite some expertise and preferably based on the use of M&V protocols that are widely recognised, as well as based on the use of Energy Savings Modelling Tools (Theme 1: Design of ECM and energy savings calculations).

The following elements should be included in the Desktop Due Diligence questionnaire:

- Measurement & Verification approach
- Use of M&V protocols
- M&V expertise and certification

The resulting questions are the following:

27.	Has a comprehensive Measurement & Verification approach been defined typically including the following core steps: 1. documentation of the baseline energy consumption, 2. establishement of the M&V plan, 3. operational perfomance verification, 4. energy data collection and 5. savings verfication and reporting?
28.	Has a simplified Measurement & Verification approach been chosen, e.g. focus on individual measures complemented by e.g additional controls or testing?
29.	Has the Measurement & Verification approach been defined following any certified M&V protocol such as IPMVP or ISO50015?
30.	Is the Measurement & Verification being serviced or supervised by a M&V certified expert?
30.a.	Is the M&V being serviced by an independent M&V certified expert?
30.b.	Is the M&V being serviced by an in-house or by the installer/contractor M&V certified expert?

Figure 17. DDD questions related to Theme 5

Theme 6: Communication with and training (awareness) of users and/or occupants

In this Theme 6. the questions address the existence of elements indicating that the ultimate users or occupants of the building subject to an energy efficiency renovation have been adequately considered. This would be the case when the energy renovation project defines and implements an approach of collection, verification and implementation of those user requirements, i.e., what users require from the implementation of the ECM, that are relevant to the user of occupants. Relevant user requirements are to be found, for instance, at the level of thermal comfort parameters (e.g., winter comfort and summer comfort levels), indoor air quality (e.g., ventilation rates, pollutants, humidity levels) or visual comfort (e.g., desired lux).

A well-conceived energy efficiency project also implements communication paths with the users to exchange feedback on implemented ECM, user's complaints related to underperformance or deficient performance, user satisfaction polls, corrective actions undertaken and achieved results.

User's behaviour is paramount to the success of an energy efficiency project. User behaviour can only evolve in the right direction if users are informed and understand the impact that their behaviour can have on the energy performance of the building. This energy awareness is a continuous effort and can take the form of action-oriented communication using all sorts of communication channels and energy awareness trainings.

Hence, the following questions address the topics of Theme 6:

- Approach for collection, verification and implementation of users' requirements
- Information process on the implemented ECM
- Energy awareness program

The resulting questions are the following:

31.	Does the project include a defined approach for collection, verification and implementation of users' requirements (e.g. comfort parameters, indoor air quality, illumination levels, operating hours,...)?
31.a.	Does the users' requirements approach take into account legal compliance, existing standards and good practices?
31.b.	Does the user's requirements approach include periodic reviews for compliance with the users' requirements?
31.c.	Does the users' requirements approach foresee corrective actions in case of deficient compliance?
31.d.	Does the users' requirements approach inlude users satisfaction surveys to test compliance with users' requests?
32.	Is there a user information process dealing with the communication of the implemented energy efficiency improvements?
33.	Is there an energy awareness program (campaign) defined to optimise user and occupants' energy awareness and behaviour (e.g. training sessions, poster campaigns, brochures,...)?

Figure 18. DDD questions related to Theme 6

3.4.3 The scoring methodology and labelling structure

As already mentioned before, for each Theme, items or elements were defined which can be standards, activities, documentation, tools, best practices, approaches or procedures that need to be in place in order to assure a well-conceived and well-implemented energy efficiency project. The existence or absence of those defined elements, which will now be objectivised in a scoring per Theme and a Global scoring, allow to have an idea of the quality of implementation and ongoing operation of the energy efficiency project and the possible risks associated with the resulting quality of implementation and operation. The better an energy efficiency project has been conceived and set-up, evidenced by the existence of the elements referred to in the different Themes, the more the risks and uncertainties surrounding the achievement of the energy efficiency savings, the size of the investment cost, the expected amounts for operation and maintenance costs and the envisaged user's requirements (e.g., comfort, indoor air quality, etc...) can be mitigated.

Based on the responses to the DDDQ the scoring model allocates, per Theme, a certain number of points to the different required elements when they are in place or intended to be in place or allocates penalty points in certain cases. The total sum of the obtained scores for the different elements results in the Global score. As a result, the higher the obtained scores within the different Themes the higher the obtained Global score will be. Consequently, the higher the Global score the higher the probability will be that the energy efficiency project will achieve its objectives in terms of energy savings, expected investment cost, expected amounts for operation and maintenance costs and envisaged user's requirements.

The purpose of this section is to provide a qualitative explanation of the relative distribution of the weight of the (maximum) scores per theme and of the (maximum/minimum) scores of the answers to the questions within one theme and, when applicable, to the sub questions within one question.

The Desktop Due Diligence scoring rationale

The following tables provide the overview of the different themes and the rationale for the relative scoring of these Themes and the underlying questions:

Table 10. Scoring rationale per Theme and per question

Theme	Scoring	Rationale
THEME 1: DESIGN OF ECM AND ENERGY SAVINGS CALCULATIONS	80	There are 3 themes that are very important for any EE project, in relation to the 3 important phases of the project life cycle: the design, the implementation and the operations & maintenance of the project and the underlaying ECM measures. This justifies why these 3 themes all count for a maximum of 80 points. Once measures are being implemented it is also important to monitor energy consumption and savings, to be able to report against the objectives and to do so in a reliable and transparent way. Achieving savings being still more reporting than showing theme, both the themes of monitoring and measurement and verification (M&V) therefore receive a slightly lower total score of 60. One final theme, related to the building users and occupants, communication and training, is certainly useful and worth evaluating, but the impact on the energy performance is less crucial and thus this theme only gets 40 points.
THEME 2: IMPLEMENTATION OF ECM (=ENERGY EFFICIENCY ASSETS)	80	
THEME 3: MAINTENANCE AND OPERATION OF THE ENERGY EFFICIENCY ASSETS	80	
THEME 4: MONITORING OF THE ENERGY EFFICIENCY ASSETS AND THEIR ENERGY CONSUMPTION	60	
THEME 5. MEASUREMENT AND VERIFICATION OF THE ENERGY SAVINGS	60	
THEME 6. COMMUNICATION WITH AND TRAINING (AWARENESS) OF USERS AND/OR OCCUPANTS	40	
TOTAL	**400**	

As can be concluded from the previous table a maximum score of 400 points can be obtained for the whole of the six Themes. This would only be the case when all the answers to all questions would indicate the existence of all the required elements.

For each Theme, different questions and sub questions were designed to query the existence of the defined relevant elements or query if these defined elements were intended to be in place. The questions also evaluate the compliance with different criteria or elements relevant for each Theme. The following tables provide a description of the rationale of the relative scoring of each question and sub question.

THEME 1: DESIGN OF ECM AND ENERGY SAVINGS CALCULATIONS		
Questions/sub questions	**Scoring**	**Rationale**
1. Has an **Energy Audit** been carried-out to define the energy efficiency savings potential of the project?	**30**	In the design phase of the ECMs and the energy calculations there are 3 main elements that need to be evaluated: • Whether and energy audit has been carried-out and how?

1.a. Has the Energy Audit been carried out by an independent and certified energy auditor following required national or international standards (e.g., EN 16247-1 or ISO 50002 (Energy Audits))?	**30**	• Whether an energy baseline (or reference consumption) has been calculated and with which level of detail? • Whether energy savings calculations have been performed using a tool and if so with which type of modelling The first element is clearly the most important one as it provides the necessary information to determine all key parameters: investments, savings and maintenance costs. This most often involves both human engineering skills and experience, as well as more or less advanced calculation modules. Because of the importance more than 1/3 of the points, i.e., max. 30 out of 80 go to this criterium. The sub questions then relate to the level of independency of the energy auditor, where a fully independent and certified auditor allow to obtain the maximum of 30, whereas external or in-house staff allow to obtain a score of 20 or even only 10, depending on the expertise. This highlights the importance of the combination of independency and expertise. The baseline (question 2) is also a very important element, but it is slightly less critical than a good audit, because in some case a simplified approach can be sufficient, without taking into account different variables that might influence consumption. It is often a question of risk assessment on behalf of the building owner. Nevertheless, if there is a good baseline, the quality, expressed in number of parameters (boundaries, length, routine correction factors and performance indicators), allow to obtain a higher score. Taking into account only a limited number of parameters, increases both the customer and the contractor's or ESCO's (and thus the financier's) risk and leads to a significantly lower quality of the baseline and thus of the score, i.e., 8. Having documented the calculations that lead to the baseline will however allow to gain some extra points, i.e., 5 on top of the previous score. The use of a modeling tool to calculate the ECM (question 3) is a clear advantage as it allows to improve the reliability of the results, at the condition that input data is reliable. But as it contributes less to the overall reliability than the human factor, it only counts for a maximum score of 10. Adding dynamic modelling and regression modelling or even another more basic form of tools allows to get some extra points, respectively 10, 7 and 4 depending on the added value. Dynamic modelling has a higher impact on quality than regression modelling only. Further points can be obtained in an equal manner, as it is difficult to precisely judge the impact of the level of experience and qualifications of the modelers, but also the detail and quality of the report. Providing such transparency is important to be able to perform third party quality checks.
1.b. Has the Energy Audit been carried out by in-house staff or third parties having considerable expertise with Energy Efficiency projects and/or Energy Conservation Measures?	**20**	
1.c. Has the Energy Audit been carried out by in-house staff with some or little Energy Efficiency expertise?	**10**	
2. Has an **Energy Consumption baseline** (the reference baseline for future comparison) been calculated capturing the total energy use prior to deploying the ECM?	**25**	
2.a. Did the Energy Consumption baseline calculation take into account all of the following: a.) the system boundaries (the component parts), b). the energy sources, c). a sufficiently long representative baseline period, d.) the impact of independent variables (e.g., weather, occupation, operational hours...) and e.) setting of Energy Performance Indicators	**20**	
2.b. Did the Energy Consumption baseline calculation take some or not all of the requirements a.) through e.) as enumerated in the previous question?	**8**	
2.c. Has a report/document been issued showing the details of the Energy Consumption baseline calculations carried out, assumptions made and underlying data used?	**5**	
3. Have the **energy savings calculations** related to the ECM been performed using a savings modeling tool officially recognised (by competent authorities) or well-reputed in the market (e.g., PHPP Passive House, BeOpt,	**10**	

eQuest, Openstudio/EnergyPlus, ResStock, RETScreen, HEED, etc., …)		Finally (question 7), in case of multiple ECMs, some points can also be lost if the interdependency of the measures has not been correctly taken into account. This can have a significant impact on the reliability of the results and justifies taken away up to 10 points of the overall score on this theme.
3.a. Has a dynamic modelling method/ tool been used?	**10**	
3.b. Has a regression modelling method/tool been used?	**7**	
3.c. Has a modelling method/tool been used different than dynamic modelling or regression?	**4**	
4. Have the savings calculations been performed by **experienced modelers**, preferably with required qualifications and/or certifications?	**5**	
5. Has a **report** been issued showing the ECM/savings modeling process including all modeling assumptions, modeling inputs and outputs and possible modeling errors and limitations?	**5**	
6. Has a **report** been issued listing all the ECM in **detail** (existing conditions, proposed renovation…) preferably ranked based on their energy savings potential with their associated implementation cost (investment cost)?	**5**	
7. Does the project envisage only one ECM (e.g., HVAC retrofit) or does the project envisage **multiple ECM** (e.g., HVAC retrofit and relighting and/or other ECM).		
7.a. If multiple ECM have been envisaged is there clear evidence that calculations have taken into account interactions (interdependencies) between measures and their impact on heating and cooling loads (demand), e.g., efficient relighting renovation might increase heat demand.	-10	
TOTAL	80	

THEME 2: IMPLEMENTATION OF ECM (=ENERGY EFFICIENCY ASSETS)		
Questions/sub questions	**Scoring**	**Rationale**
8. Is there an overall **3rd party** (Facilitator, independent engineer, architect…) **responsible for**	**30**	

<table>
<tr><td>the co-ordination and the implementation of the Energy Conservation Measures?</td><td></td><td rowspan="11">After the design phase, a second key phase for a successful energy efficiency project is the implementation phase, where ECMs are installed, and works are executed. Key success factors are related to:
• Whether someone is coordinating the implementation of the ECMs and how independent that person is.
• Whether installers (contractors) have been selected based on quality criteria or other less objective criteria
• Whether a clear installation plan has been agreed upon, including adjustment processes and penalty clauses for delays
• Whether the contractors’ contracts request for compliance with technical standards or provide for compliance with permits
• Whether there is a commissioning and verification process included and if they allow for post-installation performance analysis by a qualified expert and acceptance by the customer
• Whether sufficient documentation and training is foreseen to guarantee optimal operations

As the overall coordination of the implementation of the ECMs is a major key to a qualitative and timely delivery, this criterium has a significant score of up to 30 points, in case this coordination is in place and being provided by an independent 3rd party. In case this is done not by a 3rd party but by an experienced in-house coordinator, there are still 25 points to be gained.

The assignment of the contractors does not necessarily have to be done via a competitive bid process, as project developers often have established good relationships with trusted contractors. Nevertheless, going through such a bid process, trying to obtain an optimal price/quality ratio may be a good way to improve the overall project quality, allowing for a little 5-point scoring bonus. When other criteria than quality and price have been used, one can expect there to be an increased risk for less quality and a 5-point penalty is being applied.

An installation plan, with deadlines, is considered quite important, justifying a score of 10 points for this criterium. If a process is in place to consider adjustments, this is a small added value justifying an additional 3 points. Also, penalties in case of delays represent a small incentive that value an additional 3 points.

Compliance with technical standards and official permits will increase the quality of implementation, justifying 5 points for each of these criteria.</td></tr>
<tr><td>8.a. If not, has as an in-house coordinator with proven experience in Energy Efficiency projects been appointed to co-ordinate and oversee the implementation of the ECM?</td><td>25</td></tr>
<tr><td>9. Have the installers (contractors) of the ECMs been assigned based on a bid process that is also taking into consideration quality criteria (proven expertise, past projects, certifications…)?</td><td>5</td></tr>
<tr><td>10. Has the appointment of the installers been influenced by other elements than quality and price (e.g., personal relationship, family, by reference…)?</td><td>-5</td></tr>
<tr><td>11. Is there a well-defined installation plan of the ECM with implementation deadlines agreed with the contractor(s)?</td><td>10</td></tr>
<tr><td>12. Has a process been put in place for the possible adjustment of the initially committed implementation deadlines?</td><td>3</td></tr>
<tr><td>13. Does the contract with the installers (contractors) provide for penalties applicable in order to incentivize the installers not to exceed the installation deadlines?</td><td>3</td></tr>
<tr><td>14. Does the contract with the installers (contractors) request compliance with technical standards relevant to the implementation of the ECM?</td><td>5</td></tr>
<tr><td>15. Does the contract with the installers (contractors) provide for compliance with official permits relevant to the implementation of the ECM?</td><td>5</td></tr>
<tr><td>16. Has an agreed process been defined on how the operational performance (also called commissioning) of the ECM are going to be verified?</td><td>3</td></tr>
<tr><td>17. Is the verification methodology (visual inspection, sample spot measures, functional testing, performance testing...) per ECM/group of ECMs been defined and agreed upon?</td><td>3</td></tr>
</table>

18. Does the operational performance verification include **verification** of the necessary tools (e.g., meters, energy monitoring system…) **allowing collection and analysis** of the performance of the Energy Efficiency Assets after installation?	**3**	Verification of commissioning, having a well-defined methodology for verification and having the tools verified allowing collection and analysis of the performance are smaller quality criteria that each contribute for 3 points only, as they are less important than assuring performance and quality in the first place. The same is true for other less important, although still interesting, criteria like the supervision by a qualified or experienced expert or the presence of acceptance records. This justifies a contribution of 2 points for each of them. Finally, good documentation and training of operating staff, are also contributing to a certain extent to the overall quality and risk control, which means that having these in place justifies a small contribution of 3 points for each. Besides the importance of having a coordinator for the implementation of the ECMs, and of having a good installation plan, there are no other very important criteria. But there are many smaller elements that, if put in place, can improve the quality of that implementation and reduce project risks.
19. Is the operational performance verification being done or supervised by a qualified or **experienced energy efficiency expert**?	**2**	
20. Are there or will there be **acceptance records** evidencing formal acceptance by the client of the ECM implemented?	**2**	
21. Does the acceptance process include **documentation of technical instructions and/or operational information** (System or Operator's guide) related to the Energy Efficiency Assets in order to ensure their optimal functioning and performance during the operational phase?	**3**	
22. Does the acceptance process include **training of users or operating staff on the impact of the EEA**, their correct operation, detection of issues and possible remediation?	**3**	
TOTAL	80	

THEME 3: MAINTENANCE AND OPERATION OF THE ENERGY EFFICIENCY ASSETS		
Questions/sub questions	**Scoring**	**Rationale**
23. Does the project foresee a **Maintenance services contrac**t with a specialized 3rd party for those ECM that need maintenance in order to function optimally?	**80**	The third important phase of the project is the maintenance and operation phase. This is where the optimal exploitation of the ECMs is being assured by monitoring the correct functioning of the equipment, the correct settings of the required configuration and regulation parameters and of the energy savings. Having a maintenance contract with a trusted third party is often the best way to assure correct operations and maintenance. If this is the case, depending on various sub criteria, the project can obtain the maximum of 80 points.
23.a. Has the Maintenance contractor been procured based on a bid process that is also taking into consideration quality criteria (proven expertise, past project, certifications…)	**15**	
23.b. Is there or will there be an agreed Maintenance Plan with the contracted party clarifying the role and responsibilities of the parties including maintenance schedules	**5**	

23.c. Does the Maintenance agreement clarify the communication between the parties including the issues logging procedure and the escalation process?	**5**	As with the selection of contractors, whether the maintenance company has been procured through a competitive bid, using quality criteria is an important element that allows to obtain 15 points. Other smaller requirements that allow to gain 5 points are the existence of a maintenance plan and a clear communication approach. They are important but less essential to the project. A good practice in maintenances is having an SLA that distinguishes between different levels of importance and urgency, with various repair times. This justifies a potential contribution of 10 points. Having a maintenance contract is a good thing, having a performance-based SLA with penalties linked to repair times is even better. This is really the only way to boost the maintenance performance and thus the overall project and energy performance. This is the justification to have 25 points attached to this criterium. Having additionally also penalty clauses for repetitive or multiple malfunctions adds an extra layer of quality control, justifying another 10 points. Finally, having a recording system for malfunctions and repair lead times is another good practice, although it could also be done manually. This type of system thus counts for 5 points. If no maintenance services contract has been foreseen, there may still be some actions in place that do provide some maintenance quality. One is an internal maintenance plan, based on the system or operator's guide. This can at least allow to obtain 20 points. Alternatively, or even to complement the previous possibility, having a maintenance plan executed by an in-house expert, with expertise in energy efficiency or having the right qualification, represents a strong added value, which justifies 35 points if this criterium is met.
23.d. Does the contract with the Maintenance Party deal with different types of malfunctions (e.g., normal, urgent, critical) and their required repair times in order to safeguard optimal functioning of the Energy Efficiency Assets	**10**	
23.e. Does the contract with the Maintenance Party provide for penalties for non-compliance with repair times and/or plans?	**25**	
23.f. Does the contract with the Maintenance Party provide for a system of penalties for repetitive or multiple malfunctions?	**15**	
23.g. Does the contract with the Maintenance Party provide for a system of recording malfunctions and repair lead times for future reconciliation and proof?	**5**	
24. If no maintenance services contract has been foreseen, is there a **formal internal maintenance plan** based on the technical instructions and predictive maintenance requirements from the System or Operator's Guide?	**20**	
25. If no maintenance services contract has been foreseen, is the maintenance plan executed by **in-house expert technical staff** with energy efficiency expertise or based on relevant qualifications or certifications?	**35**	
TOTAL	80	

THEME 4: MONITORING OF THE ENERGY EFFICIENCY ASSETS AND THEIR ENERGY CONSUMPTION		
Questions/sub questions	**Scoring**	**Rationale**

26. Does the project foresee monitoring of the Energy Efficiency Assets and the related energy consumption?	60	Realizing energy savings is of course the most important thing. But monitoring how efficient ECM effectively are, what level of comfort is delivered and how energy consumption evolves in time are also important. It is the basis for M&V, which is the 5th theme, and communication and reporting, which is the 6th theme. Having a good monitoring system in place is a good foundation for evaluating performance. There are a number of criteria that are more or less of equal importance in terms of monitoring. - Having relevant key performance indicators selected. - Having a well-defined methodology for following the performance - Having an energy data collection system - Having an Energy Management System (EMS) - Having adequate training been given on the monitoring This justifies that each of these criteria has been given 10 points. Two criteria are of less importance and thus have been given 5 points. - Having the system include a Building Management System, as this adds value but is not essential to the monitoring of the ECMs - Having the system include automated fault detection and diagnostic tools, which may increase the efficiency of the monitoring, but it not essential to reaching the objective itself. When all criteria are met, the project can obtain up to 60 points for this theme.
26.a. Have key performance indicators (e.g., heating degree days, kWh consumed per building, kWh consumed per user, guaranteed energy savings…) been selected and are these KPI representative of the system operation and energy performance?	**10**	
26.b. Is there a well-defined methodology for tracking, analyzing and assessing the performance of the Energy Efficiency Assets against expected savings and selected performance indicators?	**10**	
26.c. Does the performance monitoring include a data collection system for energy data collection (meters, submeters, gateway…)?	**10**	
26.d. Does the performance monitoring include an Energy Management System allowing for the analysis and performance of the collected energy data?	**10**	
26.e. Does the performance monitoring include a Building Management System?	**5**	
26.f. Does the performance monitoring include automated fault detection and diagnostic tools?	**5**	
26.g. Does the training of operating staff responsible for the optimal operation of the Energy Efficiency Assets include specific training on the adequate use of the monitoring systems?	**10**	
TOTAL	60	

THEME 5: MEASUREMENT AND VERIFICATION OF THE ENERGY SAVINGS		
Questions/sub questions	**Scoring**	**Rationale**
27. Has a comprehensive Measurement & Verification approach been defined typically including the following core steps: 1. documentation of the baseline energy consumption, 2. establishment of the M&V plan, 3. operational performance verification, 4. energy data collection and 5. savings verification and reporting?	**40**	Even though realizing savings is the most important objective of any energy efficiency project, it can be also important to know if and how much energy savings have exactly been achieved. This is even more important in case of Energy Performance Contracts where measuring and verifying real savings against an established baseline or reference consumptions are an integral part of the business model. Penalties and bonuses depend on them. The better the M&V approach and the more it is independently supervised, the better the score obtained. Having a comprehensive M&V approach being established will allow to obtain 2/3rd of the points or 40 points, while having a simplified approach will allow for half of the points or 30 of the maximum of 60 points. M&V being a specialized area with many elements to take into consideration (baselines, routine and non-routine correction factors, statistical correlations, etc.) it makes sense to base the approach on clear guidance and well accepted principles. This also strongly increases the much-needed trust between parties and provides a good reference framework in case of disagreement between parties. Having used a widely accepted M&V protocol therefore allows to gain an additional 10 points. Finally, the M&V being serviced by an independent and certified M&V expert, adds more value, trust and expertise, and allows for 10 more points to be added. On the other hand, If the M&V expert is less independent but still certified justifies 5 points, as choices can still be made that influence the overall result.
28. Has a simplified Measurement & Verification approach been chosen, e.g., focus on individual measures complemented by e.g., additional controls or testing?	**30**	
29. Has the Measurement & Verification approach been defined following any certified M&V protocol such as IPMVP or ISO50015?	**10**	
30. Is the Measurement & Verification being serviced or supervised by a M&V certified expert?	10	
30.a. Is the M&V being serviced by an independent M&V certified expert?	**10**	
30.b. Is the M&V being serviced by an in-house or by the installer/contractor M&V certified expert?	**5**	
TOTAL	60	

THEME 6: COMMUNICATION WITH AND TRAINING (AWARENESS) OF USERS AND/OR OCCUPANTS		
Questions/sub questions	**Scoring**	**Rationale**
31. Does the project include a defined approach for collection, verification and implementation of users' requirements (e.g., comfort parameters, indoor air quality, illumination levels, operating hours…)?	20	After all the technical criteria, there is a last theme related to which extent user requirements have been considered and how communication, training, etc. is being included. This includes behavior campaigns that can even contribute to extra savings or reduce risks. If the project includes an approach for such elements, the project can already obtain $1/3^{rd}$ of the points or 20 points out of the total of 60 points. Additional points can then be obtained based on 4 equally important sub criteria: - Legal compliance and the use of standards and other good practices - Periodic reviews - Corrective actions - User satisfaction surveys Each additional feature allows for 5 extra points. It is also interesting to communicate to users the improvement measures and the results. This kind of communication increases buy-in and adds to overall commitment. Finally, and this is probably the most important aspect, having an energy awareness and behavior campaign set-up not only increases the engagement, but it can and will effectively contribute to more savings, up to $1/4^{th}$ of the overall objective in some cases and up to several % in most cases. This justifies an additional14 points out of the total of 60 points of this theme.
31.a. Does the users' requirements approach take into account legal compliance, existing standards and good practices?	**5**	
31.b. Does the user's requirements approach include periodic reviews for compliance with the users' requirements?	**5**	
31.c. Does the users' requirements approach foresee corrective actions in case of deficient compliance?	**5**	
31.d. Does the users' requirements approach include users' satisfaction surveys to test compliance with users' requests?	**5**	
32. Is there a user information process dealing with the communication of the implemented energy efficiency improvements?	**6**	
33. Is there an energy awareness program (campaign) defined to optimize user and occupants' energy awareness and behavior (e.g., training sessions, poster campaigns, brochures…)?	**14**	
TOTAL	40	

3 levels of scoring
Depending on the responses to the questions in the DDDQ the defined number of obtainable points or penalty points are being allocated to the questions. This is the first level of scoring. The obtained scores per question are then aggregated per Theme, the second level of scoring, and ultimately aggregated into the Global score, the third level of scoring.

All obtained scores for the different Themes as well as the Global score are being represented in a 5-level probability scale, with its own associated colour label, indicating the probability that the energy efficiency project will achieve its aforementioned objectives, as illustrated hereafter:

(dark green)	Very high probability	> 95% of maximum score
(light green)	High probability	Between 85% - 94% of maximum score
(yellow)	Reasonable probability	Between 69% - 85% of maximum score
(orange)	Low probability	Between 40% - 68% of maximum score
(red)	Very low probability	< 40% of maximum score

Figure 19. 5-level probability scale with associated colour

The different levels of the 5-level probability scale represent a specific range of obtained scores, or in relative terms, they represent a percentage range of the maximum score. It is obvious that, in order to be able to state that a project has, for example, a very high probability that the project achieves its objectives it must have in place almost all or all of the defined elements that need to be taken into consideration in a well-conceived and well-implemented energy efficiency project as described previously. Hence, in order to get the dark green label colour corresponding to a very high probability outcome a project must achieve, in our case, at least 95% of the maximum Global score. On the other side of the spectrum, a project with very low probability of achieving its objectives, represented by a red colour label, will most probably have only few defined elements in place. Based on the proposed labelling structure this would be the case when a project achieves less than 40% of the maximum Global score.
The relative distribution of the ranges, expressed as a percentage of the total maximum score, for the 5 probability levels is applied to the6 different Themes as follows:

Themes	Maximum score	Labelling Range									
		(red)		(orange)		(yellow)		(light green)		(dark green)	
1. Design of ECM and energy savings calculations	80	0	31	32	54	55	67	68	74	75	80
2. Implementation of ECM (Energy Efficiency Assets)	80	0	31	32	54	55	67	68	74	75	80
3. Maintenance and Operation of the Energy Efficiency Assets	80	0	31	32	54	55	67	68	74	75	80
4. Monitoring of the Energy Efficiency Assets and their energy consumption	60	0	23	24	40	41	50	51	56	57	60
5. Measurement and Verification of the energy savings	60	0	23	24	40	41	50	51	56	57	60
6. Communciation with and training (awareness) of users and/or occupants	40	0	15	16	26	27	34	35	39	40	40
Global score	400	0	159	160	273	274	340	341	378	379	400
		<39%		40%-68%		69%-85%		85%-94%		>95%	

Figure 20. Relative distribution of the labelling ranges of the 6 Themes

All colour labels, for the Global score as well as for the 6 Themes separately, receive a short description of maximum two sentences. The purpose is to provide a brief explanation and an indication of the quality of conception and set up of the project as a whole (Global score) and of the 6 different Themes separately.

The descriptions of the 5 different colour labels of the Global score, as illustrated hereafter, provide information on how the Themes have been set up in the light of standards, quality criteria and best practices and give an indication of the probability of reliability, consistency and achievability of the energy savings and minimisation of the uncertainties surrounding the investment cost and future operation and maintenance costs of the energy efficiency project.

The Colour label descriptions of the Global score are shown hereafter:

	All of the Themes have been adequately conceived and set up taking into account the **highest** standards, highest quality criteria and best practices. This level of conception and implementation of Energy Efficiency measures points to a **very high probability** that the energy savings are reliable and consistent and can be achieved and that uncertainties surrounding the investment cost and future operation and maintenance costs are being minimised.
	All of the Themes have been adequately conceived and set up, **with some minor flaws**, **almost always** taking into account the **highest** standards, highest quality criteria and best practices. This level of conception and implementation indicates a **high probability** of the envisaged energy savings being reliable, consistent and achievable and the uncertainties surrounding the investment cost and future operation and maintenance costs being minimised.
	Most of the Themes, but not all, have been properly conceived and set up though **not always** following the **highest** standards, highest quality criteria and best practices. This level of conception and implementation indicates a **reasonable probability** of the envisaged energy savings being reliable, consistent and achievable and the uncertainties surrounding the investment cost and future operation and maintenance costs being minimised.
	The majority of the Themes have been conceived and set up following **lower standards** and low-quality criteria. This level of conception and implementation indicates a **low probability** of the envisaged energy savings being reliable, consistent and achievable and the uncertainties surrounding the investment cost and future operation and maintenance costs being minimised
	Most of the Themes have not been conceived and set up properly (**poor standards** and **very low-quality criteria) and** some have not been envisaged at all. This level of conception and implementation indicates a **very low probability** of the envisaged energy savings being reliable, consistent and achievable and the uncertainties surrounding the investment cost and future operation and maintenance costs being minimised

Figure 21. Colour label descriptions of the Global score

The interested reader is referred to Annex B. Colour labels descriptions of the Six Themes of this document for the defined Colour label descriptions of the six different Themes.

3.5 RESULTS OF THE DESKTOP DUE DILIGENCE PERFORMED ON THE DEMO CASE BUILDINGS AND RECOMMENDATIONS

In this Chapter the Desktop Due Diligence Questionnaire and the scoring methodology with its associated labelling structure, which are the core of the desktop due diligence methodology, are being put into practice on the Italian and Spanish demo-case buildings.

The DDDQ-version, which is an excel sheet with different worksheets, sent to both the Italian and Spanish demo-cases included the "Questionnaire" worksheet consisting of 33 main questions, a "How to use" tab and a "Glossary and abbreviations" tab. In order not to influence the respondents, possibly resulting in biased scores, the DDDQ did not include the scoring of the individual responses neither the labelling structure nor the description of the colour labels. The first high-level analysis of the responses of the demo-cases to the different questions revealed that the way some of the questions had been drafted could leave room for some confusion and misinterpretation. The clarifications to the questions and the final input from the demo-cases allowed to improve the DDDQ and draft a final version of the "Questionnaire"-tab.

The answers from the demo-cases to the first version of the DDDQ have been included in the final version of the DDDQ. This version includes: (1) the scoring of the individual responses, (2) the scoring results per Theme and (3) the Global score and the labels descriptions.

This final DDDQ allowed to perform the following phases of the desktop due diligence, namely the analysis of the responses and the recommendations to the demo-cases.

Firstly, an analysis of the responses of the Italian and Spanish demo-case buildings to the provided Desktop Due-diligence Questionnaire and the obtained scoring and labels is being performed. This analysis includes, for their energy efficiency project as a whole (Global Score) as well as for the six different Themes, the displaying of the answers to the DDDQ and the obtained scorings and labels, as well as an interpretation and discussion of the obtained scorings and labels. The interpretations and discussions ought to be seen in the light of the set-up and implementation quality, i.e., the related risks and uncertainties of the defined six Themes.

Secondly, based on the performed analysis recommendations are then provided to the two demo-cases to improve the set-up and implementation of their energy efficiency project in order to further mitigate the risks and uncertainties surrounding the achievement of the energy efficiency savings, the size of the investment cost and the expected amounts for operation and maintenance costs. These recommendations have to be seen in the light of the specific situation, ambition and financial capability or strength of the concerned demo-case. Setting up and implementing an energy renovation project of a certain magnitude, encompassing all the elements required in the different Themes previously discussed, comes with a price (investment costs and/or operation and maintenance costs). The implementation of certain elements of the six Themes might be too expensive or prohibitive for the purpose these elements would serve or the value they would return and not worth implementing.
The recommendations only refer to those Themes for which the demo-cases have not obtained a maximum score.

3.5.1 Results of the Desktop Due Diligence performed on the Italian demo-case building and recommendations

3.5.1.1 Analysis of the Desktop Due Diligence performed on the Italian demo-case building

The analysis of the responses of the **Italian demo-case building** to the questions of the DDDQ and of the related scorings and labels is being performed in this section.

Global Score

The Table 11 hereafter shows the global scoring and the scorings on the different due diligence themes obtained by the Italian demo-case building.

Table 11. Global scoring of the Italian demo-case building

Themes	Total score	Maximum score
1. Design of ECM and energy savings calculations	70	80
2. Implementation of ECM (Energy Efficiency Assets)	80	80
3. Maintenance and Operation of the Energy Efficiency Assets	80	80
4. Monitoring of the Energy Efficiency Assets and their energy consumption	55	60
5. Measurement and Verification of the energy savings	45	60
6. Communciation with and training (awareness) of users and/or occupants	40	40
Global scoring	370	400

The Italian demo-case obtained a global score of 370 out of 400 and a corresponding light green colour label. This means that, according to the label description, “All of the Themes have been adequately conceived and set up, with some minor flaws, almost always taking into account the highest standards, highest quality criteria and best practices. This level of conception and implementation indicates a high probability of the envisaged energy savings being reliable, consistent and achievable and the uncertainties surrounding the investment cost and future operation and maintenance costs being minimised”.

Maximum scores (Dark green colour label) were obtained for **Theme 2. Implementation of ECM** (Energy Efficiency Assets) (80/80), **Theme 3. Maintenance and Operation of the Energy Efficiency Assets** (80/80) and **Theme 6. Communication with and training (awareness) of users and/or occupants** (40/40). Excellent scores (Light green colour label) were obtained for **Theme 1. Design of ECM and energy savings calculations** (70/80) and **Theme 4. Monitoring of the Energy Efficiency Assets and their energy consumption** (55/60). A reasonable score (Yellow colour label) has been obtained for **Theme 5. Measurement and Verification of the energy savings** (45/60).

From this excellent global score, we can conclude that the Italian demo-case building renovation project has been conceived and set up to be implemented successfully and the envisaged energy savings to be achieved accordingly whilst minimising uncertainties surrounding the investment cost and operation and maintenance costs. As indicated earlier, achieved energy savings, investment costs and operation and maintenance costs are key controllable drivers in the determination of the financial business case or financial outcome of any energy efficiency project. The high scores for most of the Themes provide a rather high degree of assurance that the foreseen savings can be achieved, that investment costs related to the implemented energy conservation measures to achieve the envisaged energy savings are not being underestimated and that operation and maintenance cost during the operational phase of the energy assets can be reasonably predicted and/or controlled. We can also conclude that this project will stand a very good chance of obtaining certifications from instances such as ICP (International Confidence Project) with no or very limited required additional effort.

In the following paragraphs we analyse and discuss all six Themes separately.

Analysis of Theme 1. Design of ECM and energy savings calculation

The following Table 12. shows the responses to the questions related to Theme 1. and the obtained scores.

Table 12. Scoring Theme 1 of the Italian demo-case building

			Max. scoring	Obtained Scoring
THEME 1: DESIGN OF ECM AND ENERGY SAVINGS CALCULATIONS			70	70
1.	Has an Energy Audit been carried out to define the energy efficiency savings potential of the project?	Yes	30	
1.a.	Has the Energy Audit been carried out by an independent and certified energy auditor following required national or international standards (e.g. EN 16247-1 or ISO 50002 (Energy Audits))?	Yes	30	30
1.b.	Has the Energy Audit been carried out by in-house staff or third parties having considerable expertise with Energy Efficiency projects and/or Energy Conservation Measures?	N/A	20	
1.c.	Has the Energy Audit been carried out by in-house staff with some or little Energy Efficiency expertise?	N/A	10	
2.	Has an Energy Consumption baseline (the reference baseline for future comparison) been calculated capturing the total energy use prior to deploying the ECM?	Yes	25	
2.a.	Did the Energy Consumption baseline calculation take into account <u>all</u> of the following : a.) the system boundaries (the component parts), b). the energy sources, c). a sufficiently long representative baseline period, d.) the impact of independent variables (e.g. weather, occupation, operational hours,...) and e.) setting of Energy Performance Indicators	Yes	20	20
2.b.	Did the Energy Consumption baseline calculation take <u>some</u> or <u>not all</u> of the requirements a.) through e.) as enumerated in the previous question?	N/A	8	
2.c	Has a report/document been issued showing the details of the Energy Consumption baseline calculations carried out, assumptions made and underlying data used?	Yes	5	5
3.	Have the energy savings calculations related to the ECM been performed using a savings modeling tool officially recognised (by competent authorities) or well-reputed in the market (e.g. PHPP Passive House, BeOpt, eQuest, Openstudio/EnergyPlus, ResStock, RETScreen, HEED, etc.,...)	No	10	0
3.a.	Has a dynamic modelling method/ tool been used?	N/A	10	
3.b.	Has a <u>regression</u> modelling method/tool been used?	N/A	7	
3.c.	Has a modelling method/tool been used different than dynamic modelling or regression?	N/A	4	
4.	Have the savings calculations been performed by <u>experienced modellers</u>, preferably with required qualifications and/or certifications?	Yes	5	5
5.	Has a report been issued showing the ECM/savings modeling process including all modeling assumptions, modeling inputs and outputs and possible modeling errors and limitations?	Yes	5	5
6.	Has a report been issued listing all the ECM in detail (existing conditions, proposed renovation,...) preferably ranked based on their energy savings potential with their associated implementation cost (investment cost)?	Yes	5	5
7.	Does the project envisage only one ECM (e.g. HVAC retrofit) or does the project envisage multiple ECM (e.g. HVAC retrofit and relighting and/or other ECM).	Multiple ECM		
7 a.	If multiple ECM have been envisaged is there clear evidence that calculations have taken into account interactions (interdependencies) between measures and their impact on heating and cooling loads (demand), e.g. efficient relighting renovation might increase heat demand.	Yes	-10	

Theme	Total score	Maximum score
1. Design of ECM and energy savings calculations	70	80

The Italian demo-case obtained for this Theme 1. Design of ECM and energy savings calculation a score of 70 out of 80 which corresponds to a light green colour label.

The desktop due diligence methodology defines this score as:” Design of ECM, base line and energy savings calculations have been done to high standards, with adequate tools, modelling and reporting, by highly qualified experts.”

Six out of the seven questions receive the applicable score. Question 3. (maximum 10 points), which queries whether an official recognised software or well-reputed software has been used indicating that energy savings have been calculated based on generally accepted calculations, has been answered with “No”. The desktop due diligence methodology does not penalise the absence of an official recognised or well-reputed tool for the savings calculations (as non-officially recognised, less reputed or in-house tools might deliver the same functionality, accuracy and performance depending on the skills and competencies of the developers of those tools) by deducting points but it does not reward it either. Nevertheless, the absence of an official recognised software or well-reputed software might encompass higher risks surrounding the envisaged energy savings or investment costs in the absence of any public quality indication or recognition of the used software. If the software has not been tested nor verified by independent third parties no official assurance can be given that the software does what it is supposed to do.

The use of an official recognised software or well-reputed software by the Italian demo-case would have resulted in a maximum score for this Theme 1.

Analysis of Theme 2. Implementation of ECM (Energy Efficiency Assets)

The following Table 13. shows the responses to the questions related to Theme 2. and the obtained scores.

Table 13. Scoring Theme 2 of the Italian demo-case

			Max. scoring	Obtained Scoring
THEME 2: IMPLEMENTATION OF ECM (=ENERGY EFFICIENCY ASSETS)			80	80
8.	Is there an overall 3rd party (Facilitator, independent engineer, architect,...) responsible for the co-ordination and the implementation of the Energy Conservation Measures?	Yes	30	30
8.a.	If not, has as an in-house co-ordinator with proven experience in Energy Efficiency projects been appointed to co-ordinate and oversee the implementation of the ECM?	N/A	25	
9.	Have the installers (contractors) of the ECMs been assigned based on a bid process that is also taking into consideration quality criteria (proven expertise, past projects, certifications,...)?	Yes	5	5
10.	Has the appointment of the installers been influenced by other elements than quality and price (e.g. personal relationship, family, by reference,...)	No	-5	
11.	Is there a well defined installation plan of the ECM with implementation deadlines agreed with the contractor(s)?	Yes	10	10
12.	Has a process been put in place for the possible adjustment of the initially committed implementation deadlines?	Yes	3	3
13.	Does the contract with the installers (contractors) provide for penalties applicable in order to incentivise the installers not to exceed the installation deadlines?	Yes	3	3
14.	Does the contract with the installers (contractors) request compliance with technical standards relevant to the implementation of the ECM?	Yes	5	5
15.	Does the contract with the installers (contractors) provide for compliance with official permits relevant to the implementation of the ECM?	Yes	5	5
16.	Has an agreed process been defined on how the operational performance (also called commissioning) of the ECM are going to be verified?	Yes	3	3
17.	Is the verification methodology (visual inspection, sample spot measures, functional testing, performance testing...) per ECM/group of ECMs been defined and agreed upon?	Yes	3	3
18.	Does the operational performance verification include verification of the necessary tools (e.g. meters, energy monitoring system,...) allowing collection and analysis of the performance of the Energy Efficiency Assets after installation?	Yes	3	3
19.	Is the operational performance verification being done or supervised by a qualified or experienced energy efficiency expert?	Yes	2	2
20.	Are there or will there be acceptance records evidencing formal acceptance by the client of the ECM implemented?	Yes	2	2
21.	Does the acceptance process include documentation of technical instructions and/or operational information (System or Operator's guide) related to the Energy Efficiency Assets in order to ensure their optimal functioning and performance during the operational phase?	Yes	3	3
22.	Does the acceptance process include training of users or operating staff on the impact of the EEA, their correct operation, detection of issues and possible remediaton?	Yes	3	3

Theme	Total score	Maximum score
2. Implementation of ECM (Energy Efficiency Assets)	80	80

For Theme 2. Implementation of ECM a maximum score of 80 out of 80 has been obtained, which corresponds to a dark green colour label.

The desktop due diligence methodology defines this score as: "The implementation of ECM is being co-ordinated by highly experienced 3rd parties, the choice of installers (contractors), the defined implementation process, the operational performance verification and the acceptance process are only based on the highest quality requirements."

All questions received the obtainable (maximum) scores.

Analysis of Theme 3. Maintenance and Operation of the Energy Efficiency Assets

The following Table 14. shows the responses to the questions related to Theme 3. and the obtained scores.

Table 14. Scoring Theme 3 of the Italian demo-case

			Max. scoring	Obtained Scoring
THEME 3: MAINTENANCE AND OPERATION OF THE ENERGY EFFICIENCY ASSETS			80	80
23.	Does the project foresee a Maintenance services contract with a specialised 3rd party for those ECM that need maintanance in order to function optimally?	Yes	80	
23.a.	Has the Maintenance contractor been procured based on a bid process that is also taking into consideration quality criteria (proven expertise, past project, certifications,...)	Yes	15	15
23.b.	Is there or will there be an agreed Maintentenace Plan with the contracted party clarifying the role and responsibilities of the parties including maintenance schedules	Yes	5	5
23.c.	Does the Maintenance agreement clarify the communciation between the parties including the issues logging procedure and the escalation process?	Yes	5	5
23.d.	Does the contract with the Maintenance Party deal with different types of malfunction (e.g. normal, urgent, critical) and their required repair times in order to safeguard optimal functioning of the Energy Efficiency Assets	Yes	10	10
23.e.	Does the contract with the Maintenance Party provide for penalties for non-compliance with repair times and/or plans?	Yes	25	25
23.f.	Does the contract with the Maintenance Party provide for a system of penalties for repetitive or multiple malfunctions?	Yes	15	15
23.g.	Does the contract with the Maintenance Party provide for a system of recording malfunctions and repair lead times for future reconciliation and proof?	Yes	5	5
24.	If no maintenance services contract has been foreseen, is there a formal internal maintenance plan based on the technical instructions and predictive maintenance requirements from the System or Operator's Guide?	N/A	20	
25.	If no maintenance services contract has been foreseen, is the maintenance plan executed by in house expert technical staff with energy efficiency expertise or based on relevant qualifications or certifications?	N/A	35	

Theme	Total score	Maximum score
3. Maintenance and Operation of the Energy Efficiency Assets	80	80

For this Theme 3. Maintenance and Operation of the Energy Efficiency Assets also a maximum score of 80 out of 80 has been achieved, corresponding to a dark green colour label.

The score is being defined as follows: "A Maintenance service agreement with a specialised 3rd party is in place based on the highest quality criteria ensuring optimal functioning of the Energy Efficiency Assets and minimising the possibilities of suboptimal maintenance performance by the 3rd party and/or malfunctioning of the Energy Efficiency assets."

All questions received their obtainable score.

The foreseen qualitative maintenance of the implemented assets, ensuring their optimal functioning, minimises the risks of underperforming and deficient energy assets and thus mitigates the risks of not achieving the energy savings as a result of the malfunctioning of the assets. The qualitative maintenance and operation of the energy assets also mitigates the risk of unexpected additional operation and maintenance costs (additional maintenance, unexpected repairs and replacement costs) due to non-optimal functioning or bad technical and working condition of the energy assets.

Analysis of Theme 4. Monitoring of the Energy Efficiency Assets and their energy consumption

The following Table 15. shows the responses to the questions related to Theme 4. and the obtained scores.

Table 15. Scoring Theme 4 of the Italian demo-case

			Max. scoring	Obtained Scoring
THEME 4: MONITORING OF THE ENERGY EFFICIENCY ASSETS AND THEIR ENERGY CONSUMPTION			60	55
26.	Does the project foresee monitoring of the Energy Efficiency Assets and the related energy conumption?	Yes	60	
26.a.	Have key performance indicators (e.g. heating degree days, kWh consumed per building, kWh consumed per user, guaranteed energy savings,...) been selected and are these representative of the system operation and energy performance?	Yes	10	10
26.b	Is there a well defined methodology for tracking, analysing and assessing the performance of the Energy Efficiency Assets against expected savings and selected performance indicators?	Yes	10	10
26.c.	Does the performance monitoring include a data collection system for energy data collection (meters, submeters, gateway,...)?	Yes	10	10
26.d.	Does the performance monitoring include an Energy Management System allowing for the analysis and performance of the collected energy data?	Yes	10	10
26.e.	Does the performance monitoring include a Building Management System?	Yes	5	5
26.f.	Does the performance monitoring include automated fault detection and diagnostic tools?	N/A	5	
26.g.	Does the training of operating staff responsible for the optimal operation of the Energy Efficiency Assets include specific training on the adequate use of the monitoring systems?	Yes	10	10

Theme	Total score	Maximum score
4. Monitoring of the Energy Efficiency Assets and their energy consumption	55	60

For this Theme 4. Monitoring of the Energy Efficiency Assets and their energy consumption the Italian demo-case obtained a score of 55 out of 60, which corresponds to a light green colour label.

This light green colour label is defined as "Monitoring of the Energy Efficiency Assets and their energy consumption is in place including relevant Key Performance Indicators, a methodology for tracking, analysing and assessing performance, adequate tools and systems and adequate training of operating staff. Nevertheless, tools and systems do not include either automated fault detection and diagnostic tools or a Building Management System."

Six out of the seven questions received a score. Question 26.f., which interrogates the existence of automated fault detection and diagnostic tools, has been answered "N/A". Consequently, no points were given to this question. The use of automated fault detection and diagnostic tools avoids manual triggering and processing of the performance monitoring, thus mitigates the risk of human errors. Non timely detection of faults or malfunctioning of the energy assets might result in underperforming assets and breakdowns or outages possibly affecting the achievement of the envisaged energy savings and/or resulting in increased operation and maintenance costs.

The implementation of automated fault detection and diagnostics tools would have resulted in a maximum score for this Theme 4.

Analysis of Theme 5. Measurement and Verification of the energy savings

The following Table 16. shows the responses to the questions related to Theme 5. and the obtained scores.

Table 16. Scoring Theme 5 of the Italian demo-case

			Max. scoring	Obtained Scoring
THEME 5. MEASUREMENT AND VERIFICATION OF THE ENERGY SAVINGS			60	45
27.	Has a comprehensive Measurement & Verfication approach been defined typically including the following core steps: 1. documentation of the baseline energy consumption, 2. establishement of the M&V plan, 3. operational performance verification, 4. energy data collection and 5. savings verfication and reporting?	Yes	40	40
28.	Has a simplified Measurement & Verfication approach been chosen, e.g. focus on individual measures complemented by e.g additional controls or testing?	N/A	30	
29.	Has the Measurement & Verfication approach been defined following any certified M&V protocol such as IPMVP or ISO50015?	No	10	
30.	Is the Measurement & Verification being serviced or supervised by a M&V certified expert?	Yes	10	
30.a.	Is the M&V being serviced by an independent M&V certified expert?	No	10	
30.b.	Is the M&V being serviced by an in-house or by the installer/contractor M&V certified expert?	Yes	5	5

Theme	Total score	Maximum score
5. Measurement and Verification of the energy savings	45	60

A score of 45 out of 60, or a yellow colour label, has been obtained in this Theme 5. Measurement and Verification of energy savings.

This score is defined as follows: "1.) A comprehensive Measurement & Verification approach has been defined, a.) following a certified M&V protocol such as IPMVP or ISO50015 but not supervised by any M&V-certified expert or b.) not following a certified M&V protocol though supervised by a certified expert, or 2.) a simplified M&V approach has been defined, following a certified M&V protocol and supervised by a certified expert."

The Italian demo-case has defined a comprehensive Measurement & Verification approach typically based on 5 core steps, though not following any certified M&V protocol such as IPMVP or ISO50015 as indicated by the response "No" to Question 29. The M&V is being serviced by an in-house or by the installer/contractor M&V certified expert as shown in the answer "Yes" to Question 30.b. and "No" to Question 30.a. The absence of any certified M&V protocol resulted in 10 points missed. The use of an in-house or installers/contractor M&V certified expert is being awarded 5 points whereas if the Italian demo-case had used the services of an independent M&V certified expert (Question 30.a.) 10 point would have been awarded. This accounts for the 15 points needed to obtain the maximum score of 60.

Although this Theme 5. obtains a lower rated colour label than the colour labels obtained in the preceding Themes (light green and dark green) the yellow label score can still be qualified as reasonable. The demo-case has defined a comprehensive M&V approach and has the intention to service or supervise the M&V by an in-house or installers/contractor M&V certified expert. The quality of the M&V process (e.g., baseline energy consumption calculations, making suitable routine and non-routine adjustments for changes in conditions, normalisation of the savings...) will then, of course, largely depend on the expertise and the quality of the non-independent M&V expert. These experts could find themselves exposed, though not necessarily, to situations whereby their service or supervision of the M&V process might not be possible in full independency. On the other hand, following a certified M&V protocol such as IPMVP or ISO50015 and having the M&V process supervised by an independent M&V certified expert might objectively increase the integrity of the M&V process as certified protocols and independent experts are normally supposed not to be or to be less exposed to possible biased influences from the renovation project's internal organisation. The absence of an M&V protocol and an independent M&V expert might thus include more uncertainty as to the reporting of the energy consumption and achieved energy savings versus the objectives possibly affecting ex-post financial calculations.

Analysis of Theme 6. Communication with and training (awareness) of users and/or occupants

The following Table 17. shows the responses to the questions related to Theme 6. and the obtained scores.

Table 17. Scoring Theme 6 of the Italian demo-case

			Max. scoring	Obtained Scoring
THEME 6. COMMUNICATION WITH AND TRAINING (AWARENESS) OF USERS AND/OR OCCUPANTS			40	40
31.	Does the project include a defined approach for collection, verification and implementation of users' requirements (e.g. comfort parameters, indoor air quality, illumination levels, operating hours,...)?	Yes	20	
31.a.	Does the users' requirements approach take into account legal compliance, existing standards and good practices?	Yes	5	5
31.b.	Does the user's requirements approach include periodic reviews for compliance with the users' requirements?	Yes	5	5
31.c.	Does the users' requirements approach foresee corrective actions in case of deficient compliance?	Yes	5	5
31.d.	Does the users' requirements approach inlude users satisfaction surveys to test compliance with users' requests?	Yes	5	5
32.	Is there a user information process dealing with the communication of the implemented energy efficiency improvements?	Yes	6	6
33.	Is there an energy awareness program (campaign) defined to optimise user and occupants' energy awareness and behaviour (e.g. training sessions, poster campaigns, brochures,...)?	Yes	14	14

Theme	Total score	Maximum score
6. Communciation with and training (awareness) of users and/or occupants	40	40

A maximum score of 40 out of 40, or a dark green colour label, has been obtained in this Theme 6. Communication with and training (awareness) of users and/or occupants, whereby the score is defined as follows: “A comprehensive approach for collection, verification and implementation of users' requirements has been put in place as well as a user information process on the implemented energy efficiency improvements and an energy awareness program to optimise user and occupant's energy awareness and behaviour”.

3.5.1.2 Recommendations for the Italian demo-case building

From the analysis in the previous section of the answers to the DDDQ it could be concluded that the **Italian demo-case** renovation project has been conceived and set up to be implemented successfully and the envisaged energy savings to be achieved accordingly whilst minimising uncertainties surrounding the investment cost and operation and maintenance costs.

Theme 2. Implementation of ECM (Energy Efficiency Assets), Theme 3. Maintenance and Operation of the Energy Efficiency Assets and Theme 6. Communication with and training (awareness) of users and/or occupants received maximum scores, evidenced by the dark green colour label, hence no recommendations are to be given for possible improvement of elements of these Themes.

The analysis of Theme 1. Design of ECM and energy savings calculations highlights that the Italian demo-case is not using an official recognised software or well-reputed software for the savings calculations. This does not necessarily mean that the savings calculations have not been performed according to generally accepted calculations as the use of non-officially recognised, less reputed or in-house tools might deliver the same functionality, accuracy and performance depending on the skills and competencies of the developers of those tools. The possible risk might reside in the absence of any public or independent quality indication or recognition of the used software giving assurance that the software does what it is supposed to do. It is recommended that a quality proof of the used calculation software is being provided by the developers of the calculation software (e.g., integrity tests, specific functionalities, integration of generally accepted calculation methods...) or any other credentials providing reasonable assurance of the capacity of the software to perform the calculations of the energy savings. If no reasonable assurance can be given the demo-case should envisage the use of an officially recognised or well-reputed software.

As discussed in the analysis of Theme 4 Monitoring of the Energy Efficiency Assets and their energy consumption there has been no intention to implement automated fault detection and diagnostic tools. The advantage of the implementation of these tools has to be found in the fact that these tools avoid manual triggering and processing of the performance monitoring, thus they mitigate the risk of human errors. Nonetheless, the analysis evidences that a well-defined methodology for tracking, analysing and assessing the performance of the Energy Efficiency Assets is in place, as well as an Energy Management System and a Building Management System. If the performance monitoring is well-conceived and applied correctly, with adequate checks and balances, minimising the risk of human errors, the implementation of automated fault detection and diagnostic tools would be nice to have and thus less necessary. These tools could become necessary and their implementation recommended though if the performance of the underlying energy assets would be considered as business critical to the demo-case.

From analysis of the answers to the questions in Theme 5. Measurement and Verification of the energy savings it appears that the Italian demo-case intends to have the comprehensive M&V activity performed by an in-house or installers/contractor M&V certified expert, neither based on any certified M&V protocol such as IPMVP or ISO50015. The quality of the M&V process will thus largely depend on the expertise and the quality of the non-independent M&V expert. As indicated in the analysis the absence of an M&V protocol and an independent M&V expert could thus include more uncertainty as to the reporting of the energy consumption and achieved energy savings versus the objectives possibly affecting ex-post financial calculations. This absence does not necessarily have to be an additional risk if the Italian demo-case can actually secure the services of an in-house or installer M&V certified expert and if roles and responsibilities are being clearly defined and are being abided to. To the extent that this is not possible it is recommended that the M&V process be serviced by an external independent certified M&V expert.

3.5.2 Results of the Desktop Due Diligence performed on the Spanish demo-case building and recommendations

3.5.2.1 Analysis of the Desktop Due Diligence performed on the Spanish demo-case building

The analysis of the responses of the **Spanish demo-case building** to the questions of the DDDQ and of the related scorings and labels is being performed in this section.

Global score

The Table 18. hereafter shows the global scoring and the scorings on the different due diligence themes obtained by the Spanish demo-case building.

Table 18. Global scoring of the Italian demo-case building

Themes	Total score	Maximum score
1. Design of ECM and energy savings calculations	62	80
2. Implementation of ECM (Energy Efficiency Assets)	75	80
3. Maintenance and Operation of the Energy Efficiency Assets	55	80
4. Monitoring of the Energy Efficiency Assets and their energy consumption	40	60
5. Measurement and Verification of the energy savings	35	60
6. Communication with and training (awareness) of users and/or occupants	40	40
Global scoring	307	400

The Spanish demo-case obtained a global score of 307 out of 400 and a corresponding yellow colour label. This means that, according to the label description, "Most of the Themes, but not all, have been properly conceived and set up though not always following the highest standards, highest quality criteria and best practices. This level of conception and implementation indicates a reasonable probability of the envisaged energy savings being reliable, consistent and achievable and the uncertainties surrounding the investment cost and future operation and maintenance costs being minimised".

A maximum score (Dark green colour label) has been obtained for **Theme 6. Communication with and training** (awareness) of users and/or occupants (40/40) as well as an excellent score (Dark green colour) for Theme 2. Implementation of ECM (Energy Efficiency Assets) (75/80). A very reasonable score (Yellow colour label) has been obtained for **Theme 1. Design of ECM and energy savings calculations** (62/80) and a reasonable score for **Theme 3. Maintenance and Operation of the Energy Efficiency Assets.** Weaker scores have been obtained (Amber colour label) for **Theme 4. Monitoring of the Energy Efficiency Assets and their energy consumption** (40/60) and **Theme 5. Measurement and Verification of the energy savings** (35/60). Theme 4. and 5. relate to the operations phase of the energy efficiency assets and might indicate increased risk as to the probability of achieving the energy savings or increased uncertainty surrounding operational costs due to lack of or less efficient monitoring of the energy assets.

From this very reasonable global score, it can be concluded that the Spanish demo-case building renovation project has been at least reasonably conceived and set up to be implemented successfully and the envisaged energy savings to be achieved accordingly whilst minimising uncertainties surrounding the investment cost and operation and maintenance costs. In order to not only achieve the envisaged energy savings but also secure the level of energy savings achieved in the future years the Spanish demo-case could focus on improving, if possible and financially affordable, some of the deficiencies of Theme 4. Monitoring of the Energy Efficiency assets and their energy consumption and Theme 5. Measurement and verification of the energy savings as analysed and discussed in the following sections.

The Spanish demo-case does not envisage the obtention of any quality certification, hence the energy efficiency project has not been set-up in view of any quality certification. Obtaining quality certification might require some considerable adjustments to the conception or set-up of several Themes which might require too much effort or come with a prohibitive cost to serve the purpose of the quality certification.

Analysis of Theme 1. Design of ECM and energy savings calculation

The following Table 19. shows the responses to the questions related to Theme 1. and the obtained scores.

Table 19. Scoring Theme 1 of the Spanish demo-case

			Max. scoring	Obtained Scoring
THEME 1: DESIGN OF ECM AND ENERGY SAVINGS CALCULATIONS			80	62
1.	Has an Energy Audit been carried out to define the energy efficiency savings potential of the project?	Yes	30	
1.a.	Has the Energy Audit been carried out by an independent and certified energy auditor following required national or international standards (e.g. EN 16247-1 or ISO 50002 (Energy Audits))?	No	30	
1.b.	Has the Energy Audit been carried out by in-house staff or third parties having considerable expertise with Energy Efficiency projects and/or Energy Conservation Measures?	Yes	20	20
1.c.	Has the Energy Audit been carried out by in-house staff with some or little Energy Efficiency expertise?	No	10	
2.	Has an Energy Consumption baseline (the reference baseline for future comparison) been calculated capturing the total energy use prior to deploying the ECM?	Yes	25	
2.a.	Did the Energy Consumption baseline calculation take into account all of the following: a.) the system boundaries (the component parts), b). the energy sources, c). a sufficiently long representative baseline period, d.) the impact of independent variables (e.g. weather, occupation, operational hours,...) and e.) setting of Energy Performance Indicators	Yes	20	20
2.b.	Did the Energy Consumption baseline calculation take some or not all of the requirements a.) through e.) as enumerated in the previous question?	N/A	8	
2.c	Has a report/document been issued showing the details of the Energy Consumption baseline calculations carried out, assumptions made and underlying data used?	Yes	5	5
3.	Have the energy savings calculations related to the ECM been performed using a savings modeling tool officially recognised (by competent authorities) or well-reputed in the market (e.g. PHPP Passive House, BeOpt, eQuest, Openstudio/EnergyPlus, ResStock, RETScreen, HEED, etc.,...)	Yes	10	
3.a.	Has a dynamic modelling method/ tool been used?	No	10	
3.b.	Has a regression modelling method/tool been used?	Yes	7	7
3.c.	Has a modelling method/tool been used different than dynamic modelling or regression?	No	4	
4.	Have the savings calculations been performed by experienced modellers, preferably with required qualifications and/or certifications?	Yes	5	5
5.	Has a report been issued showing the ECM/savings modeling process including all modeling assumptions, modeling inputs and outputs and possible modeling errors and limitations?	No	5	
6.	Has a report been issued listing all the ECM in detail (existing conditions, proposed renovation,...) preferably ranked based on their energy savings potential with their associated implementation cost (investment cost)?	Yes	5	5
7.	Does the project envisage only one ECM (e.g. HVAC retrofit) or does the project envisage multiple ECM (e.g. HVAC retrofit and relighting and/or other ECM).	Multiple ECM		
7 a.	If multiple ECM have been envisaged is there clear evidence that calculations have taken into account interactions (interdependencies) between measures and their impact on heating and cooling loads (demand), e.g. efficient relighting renovation might increase heat demand.	Yes	-10	

Theme	Total score	Maximum score
1. Design of ECM and energy savings calculations	62	80

The Spanish demo-case obtained for this Theme 1. Design of ECM and energy savings calculation a score of 62 out of 80 which corresponds to a yellow colour label.

This score is being defined by the desktop due diligence methodology as "One of the areas Design of ECM, base line or energy savings calculations apply lower standards, less effective tools and modelling or reporting while the other areas still perform to high standards".

By replying with a "Yes" to Question 1.b. the Spanish demo-case states that an Energy Audit has been carried out in order to define the energy savings potential of the energy efficiency project but this energy audit has not been carried out by an independent and certified energy auditor following standards but by in-house staff or a third party having considerable expertise with energy efficiency projects or energy conservation measures. The obtained score for this question is 20 out of a maximum of 30. Although experienced in-house staff or third parties can deliver a good quality of audit or even the same quality of audit as an independent and certified auditor the use of the latter ensures a quality methodology (the adopted standard) and guarantees the necessary transparency and objectivity in order to limit the risk of suboptimal choice of the ECM and their related energy savings potential. Non-adequately chosen ECM affect both the achievable energy savings and the investment cost.

Energy consumption baseline calculations have been performed following best practices and requirements ("Yes" to Question 2.a) and providing adequate reporting on the baseline calculation details, assumptions and underlying data used ("Yes" to Question 2.c), hence the obtention of a score of 25 out of 25.

In order to calculate the energy savings, the Spanish demo case has used a savings modelling tool officially recognised or well-reputed in the market using a regression modelling methodology as evidenced by the "Yes" answer to question 3 and 3.b. The obtained score is 7 out of 10 as the desktop due diligence scoring methodology favours the use of a dynamic modelling method (takes energy dynamics, interdependabilities of systems, users' management and additional simulations into consideration) over the use of a regression modelling method or any other modelling method. The savings calculations have been performed by experienced modellers ("Yes" to Question 4.) awarded 5 points but no report has been provided showing the ECM/savings modelling process, i.e., modelling assumptions, inputs and outputs, modelling errors and limits ("No" to question 5.), consequently no score could be given to this item (5 points missing). Not providing a report showing the ECM/savings modelling process does not allow to perform sanity checks on assumptions, inputs and outputs and possible modelling errors. This might result in the non-detection of possible errors in calculations and might result in wrong energy savings calculations, thus affecting the financial business case.

On the other hand, reports have been provided listing all ECM in detail with their energy savings potential as evidenced by "Yes" to Question 6 (5 points).

Lastly, the Spanish demo-case envisages multiple ECM whereby calculation of interactions between measures and their impact on heating and cooling loads has been performed, hence avoiding a possible penalty score of –10 points.

Analysis of Theme 2. Implementation of ECM (Energy Efficiency Assets)

The following Table 20. shows the responses to the questions related to Theme 2. and the obtained scores.

Table 20. Scoring Theme 2 of the Spanish demo-case

No.	Question	Answer	Max. scoring	Obtained Scoring
THEME 2: IMPLEMENTATION OF ECM (=ENERGY EFFICIENCY ASSETS)			80	75
8.	Is there an overall 3rd party (Facilitator, independent engineer, architect,...) responsible for the co-ordination and the implementation of the Energy Conservation Measures?	Yes	30	30
8.a.	If not, has as an in-house co-ordinator with proven experience in Energy Efficiency projects been appointed to co-ordinate and oversee the implementation of the ECM?	N/A	25	
9.	Have the installers (contractors) of the ECMs been assigned based on a bid process that is also taking into consideration quality criteria (proven expertise, past projects, certifications,...)?	Yes	5	5
10.	Has the appointment of the installers been influenced by other elements than quality and price (e.g. personal relationship, family, by reference,...)	No	-5	
11.	Is there a well defined installation plan of the ECM with implementation deadlines agreed with the contractor(s)?	Yes	10	10
12.	Has a process been put in place for the possible adjustment of the initially committed implementation deadlines?	Yes	3	3
13.	Does the contract with the installers (contractors) provide for penalties applicable in order to incentivise the installers not to exceed the installation deadlines?	Yes	3	3
14.	Does the contract with the installers (contractors) request compliance with technical standards relevant to the implementation of the ECM?	Yes	5	5
15.	Does the contract with the installers (contractors) provide for compliance with official permits relevant to the implementation of the ECM?	No	5	
16.	Has an agreed process been defined on how the operational performance (also called commissioning) of the ECM are going to be verified?	Yes	3	3
17.	Is the verification methodology (visual inspection, sample spot measures, functional testing, performance testing,...) per ECM/group of ECMs been defined and agreed upon?	Yes	3	3
18.	Does the operational performance verification include verification of the necessary tools (e.g. meters, energy monitoring system,...) allowing collection and analysis of the performance of the Energy Efficiency Assets after installation?	Yes	3	3
19.	Is the operational performance verification being done or supervised by a qualified or experienced energy efficiency expert?	Yes	2	2
20.	Are there or will there be acceptance records evidencing formal acceptance by the client of the ECM implemented?	Yes	2	2
21.	Does the acceptance process include documentation of technical instructions and/or operational information (System or Operator's guide) related to the Energy Efficiency Assets in order to ensure their optimal functioning and performance during the operational phase?	Yes	3	3
22.	Does the acceptance process include training of users or operating staff on the impact of the EEA, their correct operation, detection of issues and possible remediaton?	Yes	3	3

Theme	Total score	Maximum score
2. Implementation of ECM (Energy Efficiency Assets)	75	80

For Theme 2. Implementation of ECM a score of 75 out of 80 has been obtained, which corresponds to a dark green colour label.

The desktop due diligence methodology defines this score as: "The implementation of ECM is being co-ordinated by highly experienced 3rd parties, the choice of installers (contractors), the defined implementation process, the operational performance verification and the acceptance process are only based on the highest quality requirements."

All questions but one received their possible scores. Question 15., which queries the existence of provisions in the contract with the installers dealing with the compliance with official permits relevant to the implementation of the ECM, has been answered "No". Hence, no points were given to this question. A "Yes" response to this question however would have resulted in a maximum score for this Theme 2. Absence of provisions dealing with compliance with official permits might result in the implementation of non-compliant ECM which could result in regularisation costs (investment cost) or removal costs and/or loss of asset value.

Analysis of Theme 3. Maintenance and Operation of the Energy Efficiency Assets

The following Table 21. shows the responses to the questions related to Theme 3. and the obtained.

Table 21. Scoring Theme 3 of the Spanish demo-case

			Max. scoring	Obtained Scoring
THEME 3: MAINTENANCE AND OPERATION OF THE ENERGY EFFICIENCY ASSETS			80	55
23.	Does the project foresee a Maintenance services contract with a specialised 3rd party for those ECM that need maintanance in order to function optimally?	No	80	0
23.a.	Has the Maintenance contractor been procured based on a bid process that is also taking into consideration quality criteria (proven expertise, past project, certifications,...)	N/A	15	
23.b.	Is there or will there be an agreed Maintentenace Plan with the contracted party clarifying the role and responsibilities of the parties including maintenance schedules	N/A	5	
23.c.	Does the Maintenance agreement clarify the communciation between the parties including the issues logging procedure and the escalation process?	N/A	5	
23.d.	Does the contract with the Maintenance Party deal with different types of malfunction (e.g. normal, urgent, critical) and their required repair times in order to safeguard optimal functioning of the Energy Efficiency Assets	N/A	10	
23.e.	Does the contract with the Maintenance Party provide for penalties for non-compliance with repair times and/or plans?	N/A	25	
23.f.	Does the contract with the Maintenance Party provide for a system of penalties for repetitive or multiple malfunctions?	N/A	15	
23.g.	Does the contract with the Maintenance Party provide for a system of recording malfunctions and repair lead times for future reconciliation and proof?	N/A	5	
24.	If no maintenance services contract has been foreseen, is there a formal internal maintenance plan based on the technical instructions and predictive maintenance requirements from the System or Operator's Guide ?	Yes	20	20
25.	If no maintenance services contract has been foreseen, is the maintenance plan executed by in-house expert technical staff with energy efficiency expertise or based on relevant qualifications or certifications?	Yes	35	35

Theme	Total score	Maximum score
3. Maintenance and Operation of the Energy Efficiency Assets	55	80

For this Theme 3. Maintenance and Operation of the Energy Efficiency Assets a score of 55 out of 80 has been obtained, which corresponds to a yellow colour label (score between 55 and 67).

This yellow colour label is being defined as follows: "1.) A Maintenance service agreement with a specialised 3rd party is in place though some important quality criteria on one or more of the following areas are not met: procurement of the Maintenance contractor, avoidance or minimisation of suboptimal functioning of the Energy Efficiency Assets and malfunctions and repairs, or 2.) There is no Maintenance agreement in place with a specialised 3rd party but the maintenance and optimal functioning of the EEA is being done by in-house technical experts with relevant expertise based on formal internal maintenance plans."

The Spanish demo-case has no intention to engage into a Maintenance services contract with a specialised party. As a consequence, all questions 23.a. to 23.g. related to the assessment of the quality of the maintenance services agreement with the specialised party receive no score (Maximum score of 80 for the whole of the questions 23.a. through 23.g.). Nevertheless, the Spanish demo-case will have a formal internal maintenance plan based on the technical instructions and predictive maintenance requirements from the System or Operator's guide as evidenced by the "Yes" answer to Question 24. (awarded with 20 points). From answering "Yes' to Question 25. it can be concluded that the Spanish demo-case will have its internal maintenance plan executed by in-house expert technical staff with relevant expertise or qualifications/certifications, hence the 35 points obtained.

A qualitative maintenance of the implemented energy assets is paramount to ensure the optimal functioning of the energy assets and thus safeguard their potential to achieve the renovation project's envisaged energy savings and expected or defined user's requirements in terms of e.g., comfort, indoor quality, illumination levels and other project requirements.

The existence of a well-defined maintenance agreement with a specialised 3rd party, based on well-considered roles and responsibilities, maintenance schedules, repair times, penalties in case of underperformance or non-compliance of the maintenance party mitigates to a high extend the risk of a non-adequate maintenance being in place. This does not necessarily mean that the Spanish demo-case is not able to provide the same quality maintenance with its own staff as the specialised third party, it rather indicates that the at-arms-length contractual relation with the third-party maintenance contractor allows for more objective pressure and clawback on this third-party in certain cases of underperformance and from a risk mitigation perspective in general it is advisable, and when financially affordable, to have a maintenance agreement in place with a specialised 3rd party. Non-adequate maintenance or not being able to maintain and repair the assets on time (e.g., delayed access to spare parts, specialised skills, etc.) might result in underperforming and/or deficient energy assets increasing the risks of not achieving the energy savings and possibly resulting in additional operation and maintenance costs (additional maintenance, unexpected repairs and replacement costs).

On the other hand, the rather small size of the Spanish demo-case renovation project, probably translates into less complicated technical installations and energy conservation measures and the related required maintenance. Consequently, a well-considered maintenance plan executed by experienced, certified or qualified in-house technical staff can as well ensure an optimal functioning of the energy assets.

Analysis of Theme 4. Monitoring of the Energy Efficiency Assets and their energy consumption

The following Table 22. shows the responses to the questions related to Theme 4. and the obtained scores.

Table 22. Scoring Theme 4 of the Spanish demo-case

			Max. scoring	Obtained Scoring
THEME 4: MONITORING OF THE ENERGY EFFICIENCY ASSETS AND THEIR ENERGY CONSUMPTION			60	40
26.	Does the project foresee monitoring of the Energy Efficiency Assets and the related energy conumption?	Yes	60	
26.a.	Have key performance indicators (e.g. heating degree days, kWh consumed per building, kWh consumed per user, guaranteed energy savings,...) been selected and are these representative of the system operation and energy performance?	Yes	10	10
26.b	Is there a well defined methodology for tracking, analysing and assessing the performance of the Energy Efficiency Assets against expected savings and selected performance indicators?	No	10	
26.c.	Does the performance monitoring include a data collection system for energy data collection (meters, submeters, gateway,...)?	Yes	10	10
26.d.	Does the performance monitoring include an Energy Management System allowing for the analysis and performance of the collected energy data?	Yes	10	10
26.e.	Does the performance monitoring include a Building Management System?	No	5	
26.f.	Does the performance monitoring include automated fault detection and diagnostic tools?	No	5	
26.g.	Does the training of operating staff responsible for the optimal operation of the Energy Efficiency Assets include specific training on the adequate use of the monitoring systems?	Yes	10	10

Theme	Total score	Maximum score
4. Monitoring of the Energy Efficiency Assets and their energy consumption	40	60

A score of 40 out of 60 has been obtained in this Theme 4. Monitoring of the Energy Efficiency Assets and their energy consumption. This score corresponds to an amber colour label (score between 24 and 40).

This score is being defined by the Desktop due diligence scoring model as: "Monitoring of the Energy Efficiency Assets and their energy consumption is in place but does not include more than one of the following: relevant Key Performance Indicators, a methodology for tracking, analysing and assessing performance, adequate tools and systems (either data collection system or energy management system), or adequate training of operating staff."

Though the Spanish demo-case project foresees monitoring of the Energy Efficiency Assets and the related energy consumption it indicates in the Desktop due-diligence questionnaire that it has not defined a methodology for tracking, analysing and assessing the performance of the Energy Efficiency assets against expected savings and selected KPI nor does the performance monitoring include a Building Management System or automated fault detection and diagnostic tools as evidenced by the "No" answer to questions 26.b. (10 points), 26.e. (5 points) and 26.f. (5 points). A total of 20 points not awarded in this Theme 4. relates to these three questions.

The Spanish demo-case has the intention to have a performance monitoring system in place, including an Energy Management System (Question 26.d.), but, as indicated above, it has not defined yet how the performance monitoring is going to be put in place and used (Question 26.b) to analyse and assess the obtained performance data (e.g., energy consumption) against the performance expectations set during the design phase (Theme 1.) of the renovation project. The risk here is that insufficient or non-adequate data is being collected on possibly non-adequate moments and/or during suboptimal monitoring periods, making the comparison to initial expected performance very difficult, possibly affecting ex-post financial calculations.

As indicated above the Spanish demo-case does not implement automated fault detection and diagnostic tools. Nevertheless, the use of automated fault detection and diagnostic tools avoids manual triggering and processing of the performance monitoring, thus mitigates the risk of human errors. Non timely detection of faults or malfunctioning of the energy assets might result in underperforming assets and breakdowns or outages possibly affecting the achievement of the envisaged energy savings and/or resulting in increased operation and maintenance costs.

However, the implementation of a Building Management System (Question 26.e.) and automated fault detection and diagnostic tools (Question 26.f.) arguably come with an additional initial investment expense as well as an operating cost (regular monitoring, analysis and reporting). These tools, although surely increasing the quality and the capabilities of the monitoring system, might be considered as "nice to have" but not financially affordable in renovation projects of the size of the Spanish demo-case.

Analysis of Theme 5. Measurement and Verification of the energy savings

The following Table 23. shows the responses to the questions related to Theme 4. and the obtained scores.

Table 23. Scoring Theme 5 of the Spanish demo-case

			Max. scoring	Obtained Scoring
THEME 5. MEASUREMENT AND VERIFICATION OF THE ENERGY SAVINGS			60	35
27.	Has a comprehensive Measurement & Verification approach been defined typically including the following core steps: 1. documentation of the baseline energy consumption, 2. establishement of the M&V plan, 3. operational performance verification, 4. energy data collection and 5. savings verfication and reporting?	No	40	
28.	Has a simplified Measurement & Verification approach been chosen, e.g. focus on individual measures complemented by e.g additional controls or testing?	Yes	30	30
29.	Has the Measurement & Verfication approach been defined following any certified M&V protocol such as IPMVP or ISO50015?	No	10	
30.	Is the Measurement & Verfication being serviced or supervised by a M&V certified expert?	No	10	0
30.a.	Is the M&V being serviced by an independent M&V certified expert?	No	10	
30.b.	Is the M&V being serviced by an in house or by the installer/contractor M&V certified expert?	Yes	5	5

Theme	Total score	Maximum score
5. Measurement and Verification of the energy savings	35	60

The Spanish demo-case obtains a score of 35 out of 60 for this Theme 5. Measurement and Verification of the energy savings, corresponding to an amber colour label (score between 24 and 40).

The scoring level of 35 is being defined as:" 1.) A comprehensive Measurement & Verification approach has been defined though not following a certified M&V protocol such as IPMVP or ISO50015 and not serviced or supervised by a M&V-certified expert, or 2.) A simplified M&V approach has been defined, but either not following a certified M&V protocol or not supervised by a certified expert."

From the answers to the questions in Theme 5. it is clear that the Spanish demo-case has the intention to set-up a simplified Measurement and Verification (M&V) approach ("Yes" to Question 27.), not following any certified M&V protocol such as IPMVP (International Performance Measurement &Verification Protocol) or ISO50015 ("No" to Question 29.) and having the M&V serviced by an in-house or the installer/contractor M&V certified expert ("Yes" to Question 30.b.). For the positive answers to Question 27. and Question 30.b. the Spanish demo-case obtains a score of respectively 30 and 5.

Although from a quality perspective, setting up a comprehensive M&V approach based on a certified M&V protocol and serviced by an independent M&V-certified expert is the best possible approach to measuring and verifying the energy savings it mostly comes with a considerable expense and might not be the most optimal choice for smaller energy efficiency projects.

The Spanish demo-case has adopted a simplified M&V approach, though not based on any certified M&V protocol. It has also chosen to have the M&V of the energy savings done by an in-house or by the installer/contractor M&V certified expert and not by an independent one. Not following a recognised M&V protocol serviced by an independent expert means that the Spanish demo-case will have to fully rely on the M&V expertise from its own staff or from the installer/contractor, the latter certainly not being an independent party. This does not mean that the current set-up of M&V will not provide the necessary insight in the Measurement and Verification of the energy savings, it rather indicates that, in analogy with the findings related to Theme 3. Maintenance and Operation of the Energy Efficiency Assets, the independent relationship with the certified M&V expert and the use of a certified protocol might be a better guarantee for a more objective service and approach. Indeed, the in-house or installer/contractor experts could find themselves exposed, though not necessarily, to situations whereby their service or supervision of the M&V process might not be possible in full independency. On the other hand, following a certified M&V protocol such as IPMVP or ISO50015 and having the M&V process supervised by an independent M&V certified expert might objectively increase the integrity of the M&V process as certified protocols and independent experts are normally supposed not to be or to be less exposed to possible biased influences from the renovation project's internal organisation. The absence of an M&V protocol and an independent M&V expert might thus include more uncertainty as to the reporting of the energy consumption and achieved energy savings versus the objectives, possibly affecting ex-post financial calculations.

Analysis of Theme 6. Communication with and training (awareness) of users and/or occupants

The following Table 24. shows the responses to the questions related to Theme 6. and the obtained scores.

Table 24. Scoring Theme 6 of the Spanish demo-case

			Max. scoring	Obtained Scoring
THEME 6. COMMUNICATION WITH AND TRAINING (AWARENESS) OF USERS AND/OR OCCUPANTS			40	40
31.	Does the project include a defined approach for collection, verification and implementation of users' requirements (e.g. comfort parameters, indoor air quality, illumination levels, operating hours,...)?	Yes	20	
31.a.	Does the users' requirements approach take into account legal compliance, existing standards and good practices?	Yes	5	5
31.b.	Does the user's requirements approach include periodic reviews for compliance with the users' requirements?	Yes	5	5
31.c.	Does the users' requirements approach foresee corrective actions in case of deficient compliance?	Yes	5	5
31.d.	Does the users' requirements approach inlude users satisfaction surveys to test compliance with users' requests?	Yes	5	5
32.	Is there a user information process dealing with the communication of the implemented energy efficiency improvements?	Yes	6	6
33.	Is there an energy awareness program (campaign) defined to optimise user and occupants' energy awareness and behaviour (e.g. training sessions, poster campaigns, brochures,...)?	Yes	14	14

Theme	Total score	Maximum score
6. Communication with and training (awareness) of users and/or occupants	40	40

A maximum score of 40 out of 40, or a dark green colour label (score of 40 is required), has been obtained in this Theme 6. Communication with and training (awareness) of users and/or occupants

This maximum score is defined as follows: "A comprehensive approach for collection, verification and implementation of users' requirements has been put in place as well as a user information process on the implemented energy efficiency improvements and an energy awareness program to optimise user and occupant's energy awareness and behaviour".

3.5.2.2 Recommendations for the Spanish demo-case building

The conclusion of the analysis of the answers to the DDDQ of the **Spanish demo-case** is that their energy efficiency renovation project has been reasonably conceived and set up to be implemented successfully and the envisaged energy savings to be achieved accordingly whilst minimising uncertainties surrounding the investment cost and operation and maintenance costs.

Theme 6. Communication with and training (awareness) of users and/or occupants received maximum scores, evidenced by the dark green colour label, hence no recommendations are to be given for possible improvement of elements of this Theme.

The analysis of Theme 1. Design of ECM and energy savings calculations indicates that the Spanish demo-case has carried out an Energy Audit but that this energy audit has not been performed by an independent and certified energy auditor following standards but by in-house staff or a third party having considerable expertise with energy efficiency projects or energy conservation measures. The quality of the Energy Audit will thus largely depend on the expertise and the quality of the non-independent energy auditor to limit the risk of suboptimal choice of the ECM and their related energy savings potential. This does not necessarily induce increased risk if the Spanish demo-case can actually secure the services of a non-independent energy auditor (in-house, installer/contractor, architect…) based on proven expertise, quality audit methodology and transparency and objectivity. To the extent that this is not possible it is recommended that the energy audit be carried out by an independent certified energy auditor or at least that the results of the already carried-out energy audit be verified by such independent certified auditor.

Furthermore, the Spanish demo case has used a savings modelling tool officially recognised or well-reputed in the market using a regression modelling methodology. Although the DDDQ-methodology favours the use of a dynamic modelling method (takes energy dynamics, interdependabilities of systems, users' management and additional simulations into consideration) over the use of a regression modelling method the added value of dynamic modelling will most probably be found in larger energy efficiency projects where the dynamic thermal behaviour in the building might be more relevant compared to the size and purpose of the Spanish demo-case. For the Spanish demo-case dynamic modelling is not really required and would be a nice-to-have.

Finally, no report has been provided showing the ECM/savings modelling process, i.e., modelling assumptions, inputs and outputs, modelling errors and limits. As highlighted in the analysis of Theme 1, not providing a report showing the ECM/savings modelling process does not allow to perform sanity checks on assumptions, inputs and outputs and possible modelling errors. Hence the recommendation to request such a report from the provider of the energy savings calculations for sanity checking, analysis and, if necessary, discussion with the latter.

In Theme 2. Implementation of ECM (Energy Efficiency Assets) the Spanish demo-case indicates that the contract with the installers (contractors) does not provide for compliance with official permits relevant to the implementation of the ECM. As stated in the analysis of Theme 2. the absence of provisions dealing with compliance with official permits might result in the implementation of non-compliant ECM which could result in regularisation costs (investment cost) or removal costs and/or loss of asset value. It is recommended that, for the avoidance of any doubt, the contracts with the installers provide for clear roles and responsibilities as to the compliance with official permits (or the verification of compliance) when such official permits are relevant or apply to the ECM installed.

From the analysis of Theme 3. Maintenance and Operation of the Energy Efficiency Assets it is obvious that that the Spanish demo-case has no intention to engage into a Maintenance services contract with a specialised third party and that it will rather have its internal maintenance plan executed by in-house expert technical staff with relevant expertise or qualifications/certifications. Although the DDDQ methodology prefers the existence of a well-defined maintenance agreement with a specialised 3rd party (mitigates to a high extend the risk of a non-adequate maintenance being in place), a well-considered maintenance plan executed by experienced, certified or qualified in-house technical staff can as well ensure an optimal functioning of the energy assets. Indeed, the relatively small size of the Spanish demo-case renovation project (investment of €250.000) might come with less complicated technical installations (heating system, mechanical ventilation system and rather small Photovoltaic installation) and other ECM (building envelope) requiring less complicated maintenance and not justifying specialised 3rd party maintenance. Nevertheless, the Spanish demo-case will have to rely heavily on the expertise and the quality of the in-house technical staff to ensure an optimal functioning and performance of the energy assets. When this is not the case (anymore) it is recommended that a specialised third party be sought to perform the maintenance and operation of the energy assets and ensure their optimal performance.

As highlighted in the analysis of Teme 4. Monitoring of the Energy Efficiency Assets and their energy consumption the Spanish demo-case has the intention to have a performance monitoring system in place, including an Energy Management System, but it has not defined a methodology for tracking, analysing and assessing the performance of the Energy Efficiency assets yet. Monitoring the Energy Efficiency Assets and obtaining the related energy consumption on a periodic basis allows the Spanish demo-case to analyse and assess the performance of the installed Energy Efficiency Assets and compare this performance against the expected performance (e.g., in terms of energy savings) calculated during the design phase of the energy renovation project. Defining a methodology for tracking, analysing and assessing the performance of the Energy Efficiency Assets is paramount to mitigate the risk of insufficient or non-adequate data collection on possibly non-adequate moments and/or during suboptimal monitoring periods. Hence the recommendation to define as early as possible, if not done yet, a methodology for tracking, analysing and assessing the performance of the Energy Efficiency Assets.

Furthermore, the performance monitoring neither includes a Building Management System nor automated fault detection and diagnostic tools. The advantage of the implementation of these tools has to be found in the fact that these tools identify abnormal changes in values and can detect underlying problems of the operating system and thus operating performance (e.g., the BMS) and avoid manual triggering and processing of the performance monitoring (automated fault detection and diagnostic tools), thus they mitigate the risk of human errors.

However, the implementation of a BMS and automated fault detection and diagnostic tools come with additional investment expenses as well as operating cost (regular monitoring, analysis and reporting). These tools, although definitely increasing the quality and the capabilities of the performance monitoring process, might not have an added value relative to the required investment cost, thus not financially affordable in renovation projects of the size of the Spanish demo-case. Certainly not if the performance monitoring is well-conceived and applied correctly, with adequate checks and balances, minimising the risk of human errors. Hence the importance to implement as early as possible, as stated before, a methodology for tracking, analysing and assessing the performance of the Energy Efficiency Assets.

In Theme 5. Measurement and Verification of the energy savings the Spanish demo-case indicates that it has adopted a simplified Measurement and Verification (M&V) approach for measuring the energy savings, not following any certified M&V protocol such as IPMVP (International Performance Measurement &Verification Protocol) or ISO50015, and having the M&V serviced by an in-house or the installer/contractor M&V certified expert. As highlighted in the analysis of Theme 5., setting up a comprehensive M&V approach based on a certified M&V protocol and serviced by an independent M&V-certified expert is the best possible approach to measuring and verifying the energy savings, but it mostly comes with a considerable expense. For the rather limited size of the Spanish demo-case renovation project (investment € 250.000) it will most probably not justify the investment. Applying a simplified M&V approach is the next best option in this case.

For the execution of the simplified M&V for measuring the energy savings the Spanish demo-case has not chosen to have the simplified M&V serviced by an independent M&V-certified expert. The quality of the M&V process will thus largely depend on the expertise and the quality of the non-independent M&V expert (in-house or installer/contractor). As indicated in the analysis of this Theme 5., not using an independent M&V expert could thus include more uncertainty (but not necessarily) as to the reporting of the energy consumption and achieved energy savings versus the objectives, possibly affecting ex-post financial calculations. This situation does not have to result in additional risk if the Spanish demo-case can indeed secure the services of an in-house or installer M&V certified expert and if roles and responsibilities are being clearly defined and are being abided to. To the extent that this is not possible it is recommended that the simplified M&V process be serviced by an external independent certified M&V expert.

4 APPROACH FOR THE EXECUTION OF A DUE DILIGENCE AS PER THE EENVEST METHODOLOGY

This chapter aims at guiding project owners on how to collect and provide the required input data as per the EEnvest methodology and at guiding on what needs to be in place to assure high quality input data. Hence it provides an approach for input data quality assurance.

Properly checking and verifying the quality of the input data and the underlying set-up (design, implementation and operation) of the energy efficiency project, whether done internally or by a designated third party, is in fact the same as performing a due diligence.

For the different input categories, namely technical, financial and multiple-benefits, suggestions are given on what kind of data and how data need to be collected, elaborated and adjusted in order to ensure high quality input data and obtain consistent evaluation by the investment evaluation platform. Suggestions are also provided, when relevant, on what elements should be in place, in terms of e.g., documentation, tools, equipment, processes or activities, etc. in order to assure the quality of the data and the quality of the energy efficiency project.

4.1 APPROACH FOR THE EXECUTION OF A TECHNICAL DUE DILIGENCE

The energy renovation of an existing building is a complex project to build because it involves knowledge from different domain of expertise.

The EEnvest approach aims to de-risk energy efficiency projects, providing KPIs relevant to project owners and investors to progress in their decision-making process. Technical risks are identified as "an exposure to loss arising from activities such as design and engineering, manufacturing, technological processes and test procedures". According to the EEnvest approach, a technical risk, refers to the probability or threat of damage or any other negative occurrence (e.g., thermal bridge, air or water infiltration…) to the building components (e.g., architectonical elements of the building envelope, HVAC systems or RES systems). A new element is warranted by the constructor but a damage can occur for different reasons such as bad project calculation, defective installation, or manipulation) and during the different phases of the construction process (e.g., design, construction, operation...). Such occurrences affect negatively the energy performance of the technical solutions and the pre-estimated return on investment. Most probably, an additional investment will be needed to resolve the component failures.
A well-conceived renovation project identifies the final technical and economic objectives (e.g., annual kWh/m^2 energy savings, energy performance) from the very beginning of the project development.

The planning phase is the most important one, it can be considered the pillar of the renovation project. In this phase, it is necessary to acquire as much information as possible on the state of the building and the needs for improvements. Such data can be collected from different stakeholders (e.g., owners, building managers, tenants) and through interviews, surveys or existing reports.

To achieve a well-conceived renovation project, it is necessary to involve the right design team.
The composition of the design-team is adapted case by case depending on the building features or final targets. In case of deep renovation, an integrated energy design approach (IDP) is required to ensure success. It would involve a multidisciplinary group of stakeholders with different knowledge and

experiences (e.g., architects, engineers, building owners and investors). The design-team, that could be guided by a project facilitator, will work together to identify the best solution set within a wide number of possibilities, discussing, and analyzing several topics, from functional, structural, aesthetic, energy performance (energy savings), economic, cultural and management point of views. Periodical meetings will be organized to solve the ongoing problems and to discuss the solution sets through a feedback loop approval method. Ideally, all the technical solutions of the renovation project are approved during the design phase, and there will be no change proposed during the construction phase.

The energy audit assessing the status of the building prior to renovation is a key element of the design phase. It is elaborated based on an inspection of the building and its technical components. This site visit should allow for the evaluation of the energy flows of the building. The energy audit should include also a first assumption of energy renovation measures and investment cost. The energy audit should be done by qualified experts. It is suggested to include in the design-team an external energy expert with high experiences on high energy performance office buildings, certification protocols and monitoring systems. This expert will drive, verify and validate the energy performance of the renovation project, and will analyze in detail the technological solutions adopted using a cost-optimality evaluation approach and LCC (I.e., Life Cycle Costing) analysis that takes into account the investment costs of planning, design and construction phases and the operation costs as service life of the building and ordinary maintenance costs.

To increase the technical quality of the renovation project it is suggested:

- To consider the difference between the building code requirements sometimes fixed value in the calculation tools and the final use/implementation, as the internal temperature.
- To identify the building boundary condition, as climate (e.g., temperature, solar radiation, humidity, wind, orientation, …)
- To schedule the building data sets according to reality in terms of working hours, number of persons, lighting condition, temperature, etc.
- To choose the right tool (I.e., static and/or dynamic simulation), depending on the building complexity and the know-how of the design team.

Before starting to populate data in the EEnvest platform it is necessary that the user has "On hand" some necessary technical Information, the inputs required are about 200 parameters, grouped in different thematic areas:
- Building's generic Information
- Energy performance of the renovation project
- Technical data of the energy renovation measures
- Mitigation measures

4.1.1 Building renovation project

BUILDING GENERIC INFORMATION

The "Generic building information" is the data allowing the identification of each building (i.e., name to the building and address). This data is used to identify each renovation project.

Additional information completes the building identification:

- **The building dimensions:**
    - Net Floor Area (NFA), NFA is the total heated floor area (expressed in square meters, m^2) of the building measured to the internal face of the external walls, usually in such building is about the 70% of the Gross Floor Area (GFA is the total heated floor area of the building measured to the external face of the external walls).
    - Net Volume (NV), NV is the total heated volume (expressed in cubic meters, m^3) of the building measured to the internal face of the external walls.

- Dimension of the building components of external walls, roofs, basement and windows. It is the total area (expressed in square meters, m^2) of such components.
- **The climate condition - Weather context - Climate rigidity**
  - Heating Degree Days (HDD)[1] is a measurement designed to quantify the demand for energy needed to heat a building.
  - **The** Building Site Location**,** necessary to classify the building boundary condition in terms of building density, choosing between (i) Urban, when the building is located in the city, (ii) Extra-urban if the building is located in the industrial zone or if the building is located (iii) Close to the sea. These data are quite important to understand the "climate" feature and building external condition. A building located near the sea is certainly more exposed to erosion due to the saline air or characterized by a ventilate climate.

ENERGY PERFORMANCE OF THE RENOVATION PROJECT

The data required by the EEnvest platform here refers to the results of the building energy audit. Figure 22 shows the energy flows in the building, and the difference between energy "final" and energy "demand".

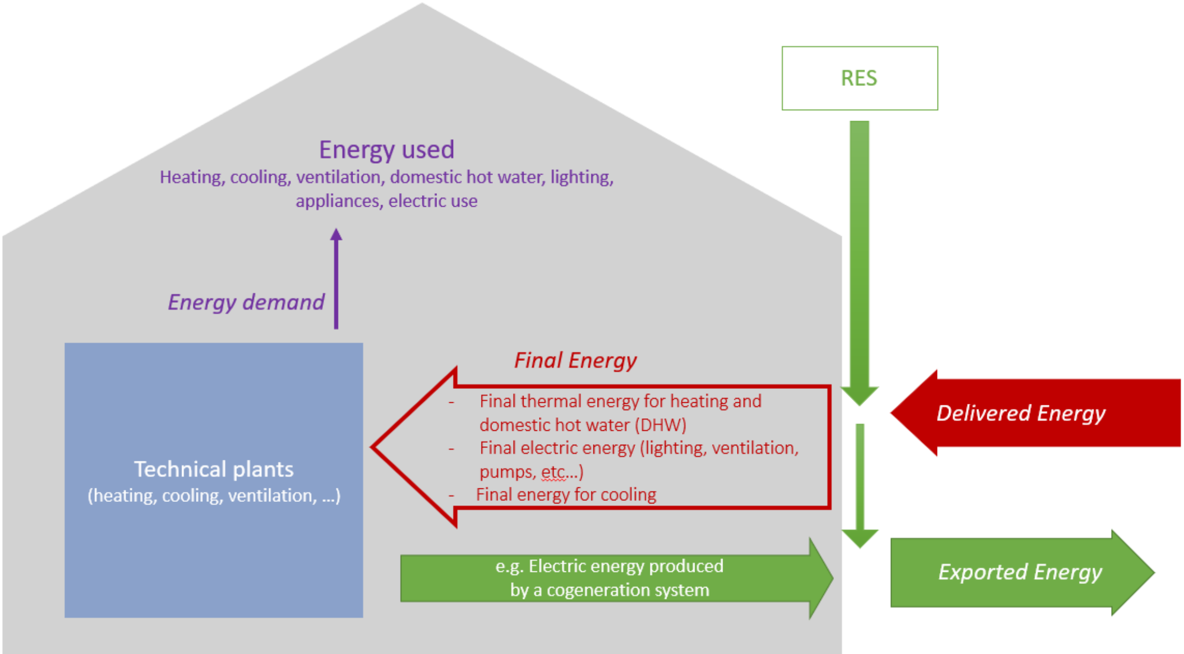

Figure 22. Energy flow diagram in building (source EURAC).

The final energy is the sum of the energy delivered by the net, and the energy produced on site by renewable energy sources (RES). It is the total amount of all the energy vectors (e.g., electricity, natural gas, district heating, woods…) delivered to each technical plant. It is the consumed energy, and it includes the energy losses of generation, distribution, emission and regulation of the technical plants for heating, cooling, and lighting the building to guarantee the indoor thermal condition and satisfy the building uses (electric consumption of appliances).

The energy demand is the energy produced by the technical plants.

[1] The heating degree days can be calculated automatically at this website (https://www.degreedays.net/), using 20°Celsius in winter season.

The HDD definition is extracted from Wikipedia and this link: https://en.wikipedia.org/wiki/Heating_degree_day

With the support of the "energy expert", during the EEnvest technical risk assessment will extract some energy performance data from the energy audit, as:

- *Heating demand,* it is the annually thermal needs to heat it's the heating space and keep it at a comfortable temperature. It is expressed in kWh/m^{2}year.
- *Final thermal energy for heating and domestic hot water (DHW),* it is the total thermal energy that a generation system produces for heating (a determined space) and domestic hot water, completed of generation, emission, delivery and transformation system losses. It is expressed in kWh/m^{2}year.
- *Final electric energy (lighting, ventilation, pumps, etc….),* it is the total electric energy for lighting, ventilation, pumps, and technical appliances. It is expressed in kWh/m^{2}year.
- *Final energy for cooling*, it is the energy produced by a technical system to cooling a determined space, completed of generation, emission, delivery and transformation system losses. It is expressed in kWh/m^{2}year.
- *Energy production by RES (Renewable Energy Source),* expressed in kWh/m2year for the installation of (i) Photovoltaics and (ii) solar thermal panels

It is suggested to have a dedicated "expert" with high knowledge on energy performance buildings, calculation methods and related tools. In a complex building, large and with a high number of technical components, the energy expert will check and verify the technical choice, the right integration, installation, functionality and regulation of the technical systems during all the projects phases. It has definitely an added value and will ensure the achievement of the results at high standards.

TECHNICAL DATA OF THE ENERGY RENOVATION MEASURES

The renovation project includes quantitative features as the energy measures and qualitative features as mitigation measures, both completed with the related costs.

To describe a renovation scenario, it is necessary to have the list the renovation measures adopted, and the mitigation measures implemented. Such information can be extracted from the energy renovation project design and from a BIM project if it is available. In any case, the architect and the energy expert have such Information.

Into the platform, the renovation measures are divided between 1) building elements of the envelope (as floor, roof, wall, ...) and 2) building equipment and services (as heating, cooling, ventilation system…). Each renovation measure adopted should be identified by:

- quantitative features as dimensional data (element area) or number of elements, respectively in square meters (m^2) and numeric value (unit). In a well-conceived renovation project these data are known and the dimension of the building elements should be the gross area calculate with the external dimension. For example, the wall area should be calculated on the external layer of the wall. Such data should be extract from the energy audit.
- qualitative features as energy performance power (kW)
- investment cost (in euro, €), it includes the materials cost, installation works, equipment (working tools), demolition, and transport to landfill. Users can find this data in the evaluation of the investment (e.g., in the Province of Bolzano, there is the public cost of building market, see https://www.provincia.bz.it/lavoro-economia/appalti/elenco-prezzi-provinciale-online.asp).
- identification of the mitigation measures adopted. Some renovation measures or technical components can have a specific mitigation measure, that if adopted can reduce the technical risks (increasing the service time of the building components and guaranteeing the performance). For example, in a new installation of a pellet boiler, a mitigation measure Is "used pellets certified by UNI EN ISO 17225-2.".

MITIGATION MEASURES

The mitigation measures are implemented or recommended to enhance the overall quality of the building renovation. When they are implemented, their cost should be considered in the total investment cost. The mitigation measures are "preventive actions", when adopted they should reduce the risk of cost deviation due to the technical risks, i.e., energy performance deviation or possible damages.

Mitigation measures can be grouped in:

Verification of energy renovation design and implementation process as certification protocols**,** such as Passive House and CasaClima, Leadership in Energy and Environmental Design (LEED). These standardized processes are able to verify the project development during different phases (design, construction, operation-monitoring). This kind of mitigation measures increases the quality of the project mainly for 3 main reasons:

- They involve at minimum two specialized energy experts, one of them external to the project, who check and verify the renovation project during all the phases (design, construction, and operation).
- They also reduce the number of technical errors, usually found in the design phase of the project development, when the changes are possible with reduced cost increase.

Finally, they reduce the probability of having an energy performance deviation impacting the business plan. In case that one, or more, protocols are used it is necessary also indicate the estimation cost (in euro, €) of such work (external building experts plus all the operation cost for the exploitation of the action).

Verification of the achievement of the results and building monitoring: to guarantee the energy savings and high level of operational performance a monitoring system and continuous Building Management System (BMS) is recommended.[2] The EN15232 standard specifies methods and guidelines to assess the impact of Building Automation and Control System (BACS) and Technical Building Management (TEM) functions on buildings energy performance. The measurement and verification (M&V) protocols for determining savings from energy efficiency projects is considered a positive process to guarantee the final results checking the energy consumptions and indoor comfort condition. In the building market there are several common frameworks, as International Performance Measurement and Verification Protocol (IPMVP), ISO 50001:2018, Energy Management Program M&V Guideline (FEMP)[10] or BPA Energy Efficiency of Pacific Northwest Power Act[11]. In case that one, or more protocols are used it is necessary to also indicate the estimation cost (in euro, €) of such work (external building experts plus all the operation cost for the exploitation of the energy conservation measure).

i. **Processes**, that affect the final quality of the project**:**
    - **Blower door test** it is a standard test method used to measure the amount of air leakage and determining airtightness of buildings. It is necessary to also indicate the estimation cost of such verification measure (in euro, €).
    - **Thermography,[3]** it is necessary to also indicate the estimation cost of such verification measure (in euro, €).
    - **ETICS guarantee/system[4]** are guidelines on 1) Quality of planning, 2) Quality of components, 3) Quality of execution, 4) Quality of maintenance. The energy expert has to check if the worker-constructor build following such guidelines.

ii. **Maintenance programs** are structured processes to verify the state of the art of technical components in terms of performance, cleaning, safety. The presence of maintenance program increases the service time of the building components. It includes a constant and periodic analysis on the whole building structure from the envelope to the technical system reducing the "technical risks" due to failures and malfunctioning and to increase the service life of components. A maintenance program should be included i) a reference person responsible to manage all the activities, and ii) a maintenance documentation plan of inspection and verification actions. Three are the maintenance program identified as mitigation measures:

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2 The new Directive (EU) 2018/844 (European Commission, 2018) requires that all non-residential buildings shall be equipped with BMS by 2025.

3 https://en.wikipedia.org/wiki/Thermography

4 https://www.ea-etics.eu/etics/system-loyality/

- **Maintenance program of the building construction**, it refers to elements of the building envelope. If adopted, it is required to identify the annual cost (in euro) of the contract with a maintenance contractor, and material costs for the maintenance.
- **Maintenance program of the thermal plants:** it refers to the technical systems (such as heating, cooling, ventilation, emission system). If adopted, it is required to identify the annual cost (in euro) of the contract with a maintenance contractor, excluded VAT and material costs for the maintenance.
- **Maintenance program for the electric system:** it refers to the electric systems (lighting, …). If adopted, it is required to identify the annual cost (in euro) of the contract with a maintenance contractor,   and material costs for the maintenance...

4.2 APPROACH FOR THE EXECUTION OF A FINANCIAL DUE DILIGENCE

One of the main features of the EEnvest platform is the calculation of the financial risks related to an energy efficiency investment. Basically, after the calculation of technical risks, the platform performs Monte-Carlo simulations to combine technical and financial variables in order to calculate the impacts of those risks to the financial indicators.
As per the EEnvest methodology, the financial due diligence is a preliminary step to input the data into the platform in order to calculate the financial indicators. In the case of energy efficiency renovation of buildings in general, there are not many variables and parameters that influence the calculation from a financial point of view. This is because, basically, return on the investment is just calculated according to the ratio between the expected energy saving and the investment cost.

However, as for the technical aspects, users shall be aware that the quality of the input data directly influences the quality and robustness of the output. Thus, in the EEnvest platform, the user is required to enter only little information about financial variables, which is processed by the technical/financial model in order to calculate the outputs. Therefore, that information shall be properly checked and verified before the upload to the platform.

4.2.1 Baseline and energy prices

As already stated in previous Sections, an accurate energy baseline is the cornerstone to build a strong and robust analysis of the investment from a financial point of view. Actually, even a well-designed technical project with an accurate estimate of energy savings could be unsuccessful if no proper assessment of the current situation of the building is carried out.

The definition of an energy baseline, in fact, should not be limited to the estimate of the theoretical current energy consumption of a building (based on standard parameters such as kWh/sqm) or just getting the total amount of energy consumed in one year from the energy bills. It is a more complex process that involves:

- An accurate and detailed analysis of the energy bills, considering a multi-year period (usually 3 full years) and paying attention to the difference between actual consumption and invoiced consumption (in particular, for natural gas, for which in most cases invoiced consumption is estimated and then balanced at the end of the thermal season);
- If available, an analysis of the data coming from energy consumption monitoring tools, which are more accurate than energy bills and can provide additional and useful information (consumption per day, hour, etc.);

- The definition of standard conditions of use of the building, in terms of operating hours, heated area and volume, comfort levels (temperature, humidity, etc.), to be used as reference.
- The assessment of external conditions that could have affected the energy consumption in each reference year, compared to standard conditions, such as: different building occupancy (e.g., an office building occupied in the evening and weekends), increase/decrease of heated area and volume.
- The measurement of the Heating Degree Days (HDD) for each season/year, from an appropriate data provider, in order to define the external climate conditions in the years used as reference for the calculation of the baseline

4.2.2 Investment cost

Investment cost represents the initial negative cash flow that, ideally, has to be covered and offset by the savings generated by the ECM in order to obtain a financial return.
Total investment cost of a project is usually split into components:

- **Construction costs**: cost of the goods, materials and labour needed for the physical implementation of the ECM. It is calculated by the project designer according to the detailed calculation of the bill of quantities and the application of prices coming from standard price lists or quotations from suppliers;
- **Provisions**: a reserve to cover potential extra-costs emerging during the construction phase. This is typically included in a prudential way in order to have a flexibility financial margin in case of need. Provisions are usually included in the overall investment cost as a percentage of construction costs (usually around 5%);
- **Technical costs**: intangible expenditures related to project design, permissions, authorisations, construction supervision, security costs, testing, etc. These costs are usually calculated in a parametric way as a percentage of the construction cost (usually between 5% and 10%);

Financial costs: immaterial costs related to the financing of the project through debt from third parties. It typically includes up-front fees and other banking costs required by banks for the issuance of senior loans, cost of surety and other warranties, etc.

4.2.3 Operation and maintenance cost

Another relevant aspect for the calculation of the financial convenience of an energy efficiency project is a correct assessment of historical (baseline) and an accurate estimate of future operation & maintenance (O&M) cost.

O&M costs, in general, shall include:

- Periodic costs of operation of the energy equipment (e.g., setup and starting at the beginning of the heating season, costs for software and control systems, external services, etc.);
- Ordinary/regular maintenance (e.g., regular cleaning, replacement of lubricants, filters, gaskets or small components, first aid intervention, etc.);
- Periodic maintenance (e.g., replacement of components at the end of their lifecycle);
- Provision for future replacement of equipment.

In many cases, it's difficult to establish a baseline cost for O&M as usually building owners/tenants don't have full-service and fixed-price O&M contracts for their thermal plants, especially for small-medium buildings. Thus, the actual historic cost could vary from year to year, according to the type of maintenance that was needed in each period. In these cases, it's important to consider the average cost incurred over a medium time period (5 years) in order to have a better estimate of an annual cost to be considered as "baseline" for the calculation of potential economic savings.

The calculation of the expected O&M cost after the renovation should instead be based on the new technological solutions installed in the building. In particular:

- The replacement of old equipment with new one will likely bring to lower need for maintenance in the first years, also considering the legal and the contractual guarantee on new products;
- New technologies could have different maintenance programs that could imply lower or higher maintenance cost (i.e., expected lifetime of LED lights is longer than traditional lights, so they imply lower maintenance cost, while the installation of a new photovoltaic plant will increase maintenance costs due to panel cleaning and ordinary maintenance of electric components).

Expected future maintenance cost should be based on reliable prices, calculated by an expert technical designer, provided by the ECM installer or based on price quotation from service providers. Expected O&M costs should also include provisions for periodic maintenance.

In the case of EPC, ordinary maintenance is always included in the service as it is the full responsibility of the ESCo to run and maintain the building equipment correctly and fully working over the contract lifetime. This is because only a regular and proper maintenance of the equipment can allow the ESCo to meet the contractually guaranteed energy savings.

The regulation of the responsibility for extraordinary maintenance instead varies according to the contractual clauses. In general, the ESCo bears full liability in relation to all newly installed energy conservation measures, while in case of extraordinary maintenance of parts of the equipment not installed by the ESCo, the responsibility remains upon the owner. In some contracts, the ESCo could also offer full-risk maintenance of all building components, but in this case the cost would be higher.

4.2.4 Financial variables

First of all, it's important to state that financial variables do not affect the technical performance of a project or the allocation of technical risks affecting the performance. When assessing the economic viability and the financial performance of an investment, financial variables only affect the net return on the own capital (equity) invested by the building owner. As a basic corporate finance concept, financing the investment partly with debt creates the financial leverage that could increase the internal rate of return (IRR) on equity. The lower the interest rate on debt, the higher the IRR on equity. Financing through debt brings another major advantage, which is the so-called "tax shield". As interests on debt are tax-deductible in the income statement, net profits will be higher in the case of debt financing instead of full equity financing.

That said, for a proper evaluation of the financial performance of an investment, economic and financial parameters need to be consistent with the project and with the offer of financial markets. In particular:

- **Leverage factor should not be too high**: in a typical project financing case, leverage factor is about 70/30, meaning that 70% of the project investment cost is financed through a senior banking loan. Banks don't usually cover the whole amount of the investment without proper guarantees. The leverage factor to be used in the financial planning of the investment could thus consider these limitations and should preferably be based on actual agreements with the bank;

- **Interest rate and loan duration should be consistent with banks offering**: in the financial planning, it's important to take prudent assumptions on the financial variables such as the cost and the length of the loan. Even though a rough estimate of these variables could be done according to previous experience in similar projects, it's always recommended to obtain this preliminary information directly from the bank. Another thing to always keep into consideration is that the risk of variability of interest rates can be covered through a financial hedge instrument (IRS – Interest Rate Swap). While the decision whether to hedge the risk or not is up to the project owner, it must be taken into consideration that a floating-rate loan might require the subscription of an IRS, whose price depends on the financial markets.
- **Inflation rate should be consistent**: inflation rate has a direct impact on cash flows and on main project results (IRR in particular). In projects with a positive margin (revenues higher than costs), if all figures are indexed at the same rate, a higher inflation rate implies a higher expected return. In order to avoid overestimates of these returns, it is important to consider a prudentially low expected interest rate, or even calculate the project outcomes considering a zero-inflation rate (in this case, for the calculation of the NPV, the inflation portion should be excluded from the nominal discount rate – WACC);
- **Taxation**: according to common accountability, corporate profits are subject to taxation. In the case of energy efficiency projects, profits derive from lower costs, all else equal. So, energy savings could be considered as "extra-profits" that will be taxed at the end of the year. Project IRR should thus be better calculated net of taxes (post-tax IRR), in particular in the case of debt financing, which benefits from tax shield.

4.3 APPROACH FOR THE EXECUTION OF A DUE DILIGENCE ON THE MULTIPLE BENEFITS

The EEnvest methodology on multiple-benefits consists on providing qualitative information for the project promoter (in some cases also the building owner) and a mix between qualitative and quantitative metrics for external investors such as retail banks. The scope of this report focuses on the methodology for project promoters and proposes 6 KPIs and shown in the table below.

In a nutshell, the methodology for project promoters consists of 6 multiple-benefits KPIs that depicts the non-energy impact of deep energy renovation project as a result of the selected set of measures of the retrofit project. The results of these estimations are classified under a Likert Scale which determines whether the computed multiple-benefit KPIs lies on the ideal range. The recommended ranges are based on international standards as well as research on related certifications such as WELL and FITWELL.

The multiple-benefits KPIs for project promoters are presented in Table 25 below.

Table 25. Short-listed MBs KPIs for project promoters and their ideal range Source: GNE Finance, T4.2, 2020

Code	KPI	Unit	Scale				
			1	2	3	4	5
M_O.1	Thermal comfort	°C	< 19°C / > 29°C	19°C - 29°C	21°C - 27°C	22°C - 26°C	23°C - 25°C
M_O.2	Visual comfort	lux	< 500lux / > 750lux	650lux - 750lux	600lux - 650lux	550lux - 600lux	500lux - 550lux

M_O.3	Perceived physical and mental health	-	Unhealthy, mental and/or physical pathologies - Marked worsening	Declining health - Slightly worsening	Neutral - Same	Healthy - Slight improving	Very healthy - Marked improving
M_O.4	Air quality	ppm	> 2500ppm	< 2500ppm	< 2000ppm	< 1500ppm	800ppm - 1000ppm
M_O.5	Productivity	%	< 0.9BL	< 0.95BL	BL	> 1.05BL	> 1.1BL
M_O.6	Acoustic Comfort	db(A)	>50 db(A)	[40,50] db(A)	[35,40] db(A)	[30,35] db(A)	[20,30] db(A)

Due to the nature of these benefits (i.e., benefits of second order) it's not feasible to estimate the precise improvement on each multiple benefit in relation to the selected renovation measures. Thus, the underlying assumption is that all renovation works, specifically deep renovations, will in all cases increase the scoring of multiple benefits. As such, the upcoming paragraphs will present how to properly measure these KPIs.

A competent due diligence approach on Multiple-Benefits provides all the necessary guidelines to measure each KPI before the renovation. This point deserves special mention.

The ideal scenario for an accurate multiple-benefits estimation consists of benchmarking the Ex-Ante estimate with the Ex-Post outcome and thus determine the increase on each multiple-benefit parameter. Although the ideal scenario for multiple-benefit is data dependent, the next paragraphs present an approach to secure an appropriate monitoring of MBs KPIs along the project's lifetime as well as the correct guidance and equipment to do so. In fact, the following sections are the first steps to promote data gathering in the industry, with a strong focus on SMEs, building owners and project promoters.

The 3 steps to prepare for a due diligence execution on MBs are the following:

Step 1. Understanding the input required to measure each MBs KPIs

MBs are strongly related and thus there are different methodologies to compute them. The EEnvest Project defined a specific methodology for computing these KPIs as a means to promote standardization in the field.

Step 2. Checking whether the necessary tools and surveys to measure the input are at hand

Likewise, as there are different means to compute MBs there are also different tools for measuring MBs. In the light of making MBs accessible to everyone, including SMEs, the EEnvest methodology recommends using affordable but yet innovate smart sensors (Ibiot, Flir One) as well as iPhone/Android Apps.

Step 3. Ensuring the best conditions and timing for measuring each KPIs

Ensuring an accurate measurement on the MBs parameters requires a representative set of data points under realistic conditions and time frames. Thus, measuring MBs with a single set of data points will be highly likely inaccurate and therefore not representative of the real impact of the DER project.

In terms of measurement conditions, the EEnvest methodology defines the following scenarios:
Hot measurement: It refers to the measurement procedure with building occupants inside the building. Further, it's recommended to conduct the measurement procedure under normal conditions. For example, is the average number of employees per floor is 40, then the hot scenario for running the computation is exactly that one.

Cold measurement: It alludes to the measurement procedure with no occupants inside the building. Evidently, this scenario is not recommended as the data gathered will not be representative enough to conclude the computation of the multiple-benefit KPI. For example, the Indoor Air Quality metric will be severely affected, as building occupants exhale CO2.

In addition to these 3 steps, it's important to highlight the fact that each multiple-benefit has its own ideal time series of data, meaning than the longer the data set the more reliable the computation will be.

The next paragraphs explain how to compute the 6 EEnvest Multiple-Benefits KPIs.

1. Thermal Comfort

Thermal comfort is defined by the minimum and maximum temperatures in both, summer and winter. The suggested equipment to compute Thermal Comfort are smart sensors, such as Inbiot, FLIR ONE or alike. Important to note that once having the equipment, the measurement procedure is rather trivial and thus it only depends on the willingness to measure the KPI.

In the light of having reliable data, it's strongly suggested to run the measurement for a year-round as some buildings may have problems for winter time whereas other buildings for summer time. If this is not possible, the measurement must be conducted at least for a cycle of 24 hours to get the maximum and minimum temperatures of the day.

Further, the hot scenario suggests to run the computation with people inside the buildings, as per an average workday. If the building has many floors, it's recommended to run the methodology in all floors and specially near the most sensitive areas such as near the windows and those areas with the highest concentration of occupants. In the case that it's not feasible to measure in all floors, then the approach is to measure on the first and last floor of the building. In respect of the quantity of sensors needed, it's subject to the project promoter or building owner.

All in all, the main point is to compute the KPI under the most realistic scenario and ideally for a large period. Once the data is properly gathered, the next step would be to check whether the Thermal Comfort falls within the seasonal permitted range.

2. Visual Comfort

Visual Comfort is computed based on Daylight Autonomy (DA) and it's measured by using a luxmeter or colorimeter. With the appropriate equipment at hand, the procedure consists of three steps:

- Baseline or ambient light level: Turn off all lighting in the room about to measure.
- Illuminated level: Turn on lights from a central area of the room
- Compute Delta: Subtract the baseline or ambient light level from the illuminated level to get the amount of light the existing luminaires produce.

In order to make the computation representative enough, it's recommended to measure key points of the office space. For instance, if most of the occupants work in specific desks or meetings rooms, it's suggested to measure in these areas. The guiding rationale is that the more natural light, the better for the building occupants.

3. Acoustic Comfort

Acoustic Comfort is, in the best-case scenario, measured through impact noise (Hz) and Airborne noise (db(A)). The professional equipment to compute this KPIs is a sound level meter. However, nowadays there are a few "reliable" phone apps (I.e., Apple and Android) that are accurate for measuring these inputs but these options are rather used for internal communication rather than external communication.

Computing impact noise is rather complicated. This is achieved by using 16 frequencies to determine the Transmission Loss which is compared with standard Sound Transmission Class curves. It's suggested to measure only the Airborne noise, unless the building needs to guarantee a Sound Transmission Class.

For the case of Airborne Noise (I.e., ambient noise level), the procedure is rather straightforward. The process is to obtain a point estimate of Airborne noise in db and check whether it is below or above the threshold, as shown in Table 25. As reference, 30 db(A) value refers to recommendation Normative SBM 2015 Baubiologie Institue[5] (GE).

Last, it's recommended to measure under the most unfavorable scenario, which refers to the specific context where the most noise occurs. For instance, if the building is located next to a school, the recommended context would be during the school's breaks.

4. Air Quality

The computation of the Air Quality metric is similar to measuring Thermal Comfort. Thus, the suggested equipment for estimating this KPI are smart sensors, such as Inbiot and FLIR ONE.

In order to gather high-quality data, it's strongly recommended to install the smart sensors in the areas with major concentration of workers such as individual desks and meetings rooms. Further, to make the estimation as accurate as possible, it's suggested to run the measurement in all floors as well as during a large period of time. Once the data is gathered, the next step is to assess whether the result falls in the ideal range, as defined in Table 25 above.

An important remark is that larger concentration of CO2 boosts fatigue, which in turn affects productivity and therefore this KPI is of strong interest for business owners.

5. Perceived physical and Mental health

This KPI is determined via questionnaires as it's strongly subjected to the perception of physical and mental health of each individual building occupant. The EEnvest methodology for computing this KPI is rather straightforward, and it proposes the following survey[6] developed by the WHO.

The methodology consists on doing the survey on ex-ante basis (i.e., the baseline) and then, doing the same survey ex-post to then compare the improvement on the health status of the building occupant.

The key point is to run the survey before the renovation project. In the case that the project already started, then it's suggested to consult with the Human Resources department to assess whether there is any data related with physical and mental health of building occupants.

[5] For an exhastive review of the normative, please refer to: https://buildingbiology.com/site/wp-content/uploads/randbedingungen-2015-englisch.pdf

[6] https://www.who.int/mental_health/who_qol_field_trial_1995.pdf

6. Productivity.

There are three dimensions in which productivity gain, as result of the DER project, can be computed. These are the following:

- **Increase productivity value** is computed as the product of number of employees, average salary cost per employee and the increased productivity per employee. The IPV can be discounted in time by the annual discount rate (R). The defined baseline is 0.5%. Ought to remark that this methodology requires the increase productivity per employee, which in literature is defined by ~5%.
- **Turnover employee reduction,** refers to the difference between the number of employees before and after the DER project, weighted by the total of employees in a defined period of time. The typical value is 0.5%.
- **Reduced Number of sick days claimed by the employee.** The typical value that can be found in literature is an increment of 4.5 active work days per employee, as results of the DER project.

Table 26 below elaborates in depth these three methods.

Table 26. Methodology to compute Productivity after a DER Project, Source: GNE Finance, T4.2, 2020

KPI	ID	Cluster Group(Beneficiaries)	Specific Goals	Evaluation	Benchmark	Rating	Description
Increase Productivity Value	IPV	Productivity (business owner, employee)	Increase in productivity derived from DER in office buildings	IPV=ExSCxI The salary cost per employee (SC) x number of employees (E) Increase in Productivity (I~5%)	Typical Value: 0.5% Range: [0.3%-0.76%]	IPV refers to building, it requires the Increase Productivity per employee ~5%	Productivity gain in office buildings (euros or euros/m2) can be discounted with the risk free rate of return r
Turnover	PRO_T	Productivity (business owner, employee)	Reduction in turnover employee derived from DER in office buildings	Turnover/year count	Typical Value:0.5%	Nb employees variation/Nb Total employees	Difference between employees before and after the DER weighted by the total of employees in a time period
Sick days	PRO_S	Productivity (business owner, employee)	Number of sick days claimed by the employee	Sick days count	Typical Value:4.5 days. Baseline 7.5%	2 alternatives: i. count the number of sick days, or ii. compute increase in productivity by the reduce loss of work force days	Reduction in the number of sick days on average for a building. Alternatively, possible to use the productivity gain in % related to the reduction of sick days (7.5%)

As final remark, the required data to compute the productivity increase is subjected to the business owner, i.e., Human Resources department, data availability.

5 CONCLUSION

This report started presenting the energy renovation strategy of two demo-case buildings participating in the EEnvest project (i.e., Rome, Italy and Olot, Spain). Then it exposes the data project quality assessment assurance approach. Finally, in the framework of the EEnvest methodology, it explains the execution of technical, financial and multiple benefits due diligences.

The two demo-case buildings differ in building size (24.470 m² of heated space for Rome, Italy versus 400 m² for Olot, Spain), but also in the magnitude of the ECM investment required and their energy savings ambition. Indeed, the Italian demo-case could be qualified as a mid-sized energy efficiency project (€ 1.409.000) whereas the Spanish demo-case concerned a rather small project (€ 250.000). Despite its small size the Spanish demo-case envisaged a deep retrofit of the building, including technical installations and building envelope, targeting 97% energy savings whereas the Italian demo-case focused on the technical installations with a 37% energy savings target.

Because the EEnvest methodology relies heavily on the quality of the input data, a desktop due diligence process has been created and carried-out on the demo-case buildings. The purpose of this Excel-based tool is to provide an indication of the probability that the respective projects would achieve their objectives. The developed tool consists in a series of 33 main questions classified in six Themes covering the different stages of an energy efficiency project. The result of the questionnaire is a commented score by theme and a final scoring. For each demo case, an analysis of the answers has been performed, including an interpretation and discussion of the obtained scorings and labels. This analysis has been followed by recommendations to improve the set-up and implementation of the energy efficiency projects planned in order to further mitigate the risks and uncertainties.

The main conclusion for the Italian demo-case project is that it was conceived and set up to be implemented successfully, providing a high degree of assurance that the objectives will be achieved and the uncertainties minimized. A few recommendations aiming at improving the energy savings calculations, the monitoring tools and the measurement and verification of the energy savings have been formulated.

The main conclusion for the Spanish demo-case project is that it was reasonably conceived and set up to be implemented successfully and the objectives to be achieved. The analysis highlighted some deficiencies in the Themes related to the monitoring of the energy efficiency assets and their energy consumption and measurement and verification of the energy savings. Recommendations for improvement have been provided for the following areas: Design of the ECM and energy savings calculations, implementation of the ECM, maintenance and operations, monitoring of the assets and their energy consumption and measurement and verification of the energy savings.

This report shows how the EEnvest methodology addresses the necessary input data quality assurance developing a desktop due diligence tool providing recommendations and guidelines to the 3 pillars of the EEnvest methodology (i.e., technical and financial risk assessment and multiple-benefits analysis). On the one hand, the project owner can perform the risk weighting on the ECMs envisaged based on the way the different EE project phases have been designed and will be implemented, and on the other hand he/she receives suggestions to improve the project set-up. In addition, the scores obtained by themes are also interesting information for the investors looking at EEnvest final KPIs. Good scores will reinforce their confidence in the platform results and complement the information provided by a straightforward benchmark between projects.

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Annex A Description of examples of Quality Approach to Energy Efficiency projects

The energy efficiency procurement model smartEPC, developed by Energinvest, and the two identified European Projects, Horizon2020 projects QualitEE and Investor Confidence Project ICP, focusing on the quality of implementation of energy efficiency projects as presented in Chapter 3.3. of this report are being briefly described hereafter.

SmartEPC, Energinvest

smartEPC was designed to meet a number of specific requirements and options of which the following can be relevant for the Desktop Due Diligence Questionnaire:

- Compatible with Public Tendering Law in Belgium
- Highly performance driven
- Focus on Technical/Operational aspects
- Output driven solution for maintenance and comfort
- Excel based Tendering document annex
- Document management orthodoxy
- High degree of standardization and modularity
- Responsibilisation of the Energy Services Company (ESCO): Design & Engineering (based on documented ECM files), Maintenance, M&V-plan, non-routine adjustments.

The core of smartEPC is based on an extensive table defining all applicable Project Requirements which are being grouped into eight Themes. These Project Requirements encompass all the details of the envisaged energy efficiency project, providing a clear guidance related to the defined requirements, instruments and tools, expectations, penalties and bonusses, and quality management.
smartEPC defines the following eight Themes:

- Theme Condition
- Theme Functionality
- Theme Safety
- Theme Comfort and Health
- Theme Energy
- Theme Environment
- Theme Project organisation
- Theme Information

In order to comply with the Project Requirements, the ESCO needs to unequivocally describe in a Project Plan how the Project Requirements are going to be met. The Project Plan is basically the bundling of the relevant Theme Plans as all Project Requirements are being allocated to Themes. Every Theme Plan describes unequivocally how the Theme Project Requirements are going to be met and it mandatory includes an ECM table highlighting all proposed ECM, a measures file per ECM with detailed description and documentation of the ECM and all other information necessary to be able to assess how the Project Requirements are going to be met. The ESCO is also required to draft a Measurement and Verification (M&V) Plan following the International Performance Measurement and Verification Protocol - IPMVP (EVO,2016).

The eight Themes are briefly described hereafter:

Theme Condition

Project requirements for this Theme relate to the minimum condition (physical and technical state) or value retention (retaining the highest value or keeping at highest use) of the energy assets during the contract term (based on the NEN2767 standard as mentioned earlier) and to compliance of the ECM with technical standards, official permits, legal obligations, legal controls, but also compliance of the ECM with the implementation requirements file.

Theme Functionality

In this Theme the Project Requirements are intended to guarantee the optimal functioning of the Energy Efficiency Assets and focus on dealing with malfunctions and the types of malfunctions, repair times, penalties for non-compliance and decommissioning of installations.

Theme Safety

This Theme deals with all possible and applicable requirements related to all aspects of safety: compliance with fire security regulation, safety related legal obligations, asbestos removal procedure, building safety regulations and specific project related safety requirements.

Theme Comfort and Health

Users' requirements are being defined in this theme. These requirements usually relate to temperature comfort, visual comfort, Indoor Air Quality, water temperature and water quality and also building aesthetics. This Theme can also include user satisfaction assessment requirements.

Theme Energy

Specifically, the energy savings requirements are being defined in this Theme.

Theme Environment

Focuses on the compliance with environmental regulation related to waste materials, specific project guidelines related to waste material, regulation on wastewater and atmospheric emissions.

Theme Project organisation

This Theme covers a panoply of requirements intended to make sure that the necessary processes, procedures, tools, systems and risk mitigation measures are in place. Typical requirements focus on guidance related to the service provider's staff, integrity, required insurances, information systems (ICT requirements), guidelines on energy monitoring system, guidelines on incidences and events and the related information duty.

Theme Information

The Project Requirements in this Theme ensure that all relevant information necessary to assess the compliance with all Project Requirements is in place. The information must be readily and easily controllable and verifiable by any other party not related to the service provider/contractor. The requirements in this section define the availability of information related to all the defined requirements in all other Themes. They also define the requirements related to the Project Plan, the ECM files, the Measurement & Verification Plan, the handover files and the asset item identification list.

The smartEPC procurement model provides project owners with all necessary instruments to ensure a highly qualitative implementation and operation of their energy efficiency project and as such, as is common to any Energy Performance Contract, transfer all necessary risk to the ESCO.

QualitEE project, EU H2020 project

In order to meet its objective of increasing investment in energy efficiency services in the building sector within the EU and improving trust in service providers the QualitEE project developed the following three tools:

- Guidelines of European Technical Quality Criteria for Energy Efficiency Services
- Financial Guidelines for Energy Efficiency Services
- Procurement Handbook for Energy Efficiency Services

The **Guidelines of European Technical Quality Criteria for Energy Efficiency Services** are particularly interesting and are being described hereafter.

These quality criteria (QC) are categorised in nine relevant topics, which, according to QualitEE, secure the quality of energy efficiency services due to the whole service process from project identification to the contract expiration of the contract.

The nine quality criteria are briefly presented hereafter:

<u>QC1: Adequate analysis</u>
This topic refers to the detailed analysis of the project potential with focus on the following assessment criteria: the agreement of the process of energy analysis, the adequate data collection and analysis and finally the adequacy of the derivation of recommended energy efficiency improvement (EEI) measures.

<u>QC2: Quality of implementation of technical energy efficiency improvement measures.</u>
This quality criterium includes assessment criteria such as the performance of services in accordance with applicable standards, statutes and official permits, the on-schedule delivery, the commissioning of services and documentation of services rendered, the induction of users or operating personnel and ultimately ensuring the functionality of newly installed facilities after the end of the Contract

<u>QC3: Savings guarantee</u>
Here assessment criteria for the common definition of the saving guarantee in the specific contracts are being delivered. This quality criterium looks into the dependency of remuneration on adherence with the savings guarantee, the guaranteed savings achieved (as applied in Energy Performance Contracts) and the adequate intervals for the verification of compliance with the guarantee promise.

<u>QC4: Verification of the savings</u>
This quality criterium provides the criteria to reach a common agreement on how the savings are measured, calculated and verified. It considers the application of a standardised method for the calculation of energy-savings, the selection of the most appropriate approach to the verification of energy savings, a clear definition of the baseline (reference consumption), a clear definition of the basis of adjustment of the energy savings calculation and the transparency and agreement of M&V processes and related responsibilities.

<u>QC5: Value retention and maintenance</u>
Emphasising on a clear strategy on maintenance, troubleshooting and responsibilities this quality criterium deals with the compliance with the required system availability, the rapid troubleshooting in case of malfunctioning of technical systems, the functionality of facility at the end of the contract and the clear definition of responsibilities of the service provider with respect to maintenance and repair.

<u>QC6: Communication between the EES provider and the client</u>
This QC defines which communication elements should be defined, namely the disclosure of the contact persons, the agreement on accessibility of data and data exchange (in both directions), the capturing and continual updating of all EEI measures taken by the EES provider and the organisational measures for committing internal operating personnel.

<u>QC7: Compliance with user's comfort requirements</u>
The importance of agreeing the desired comfort conditions contractually is here highlighted. The assessment criteria include the definition of users' requirements (including regular review), the regular verification of compliance with physical comfort parameters and the assessment of users' satisfaction

<u>QC8: Information and motivation of users</u>
As it makes sense to motivate the user to save energy this quality criterium focuses on the development of a concept for the motivation of users, the establishment of a suggestion scheme for clients to improve energy efficiency and the provision of action-oriented information on the subject of energy efficiency.

<u>QC9: Comprehensible contractual stipulations for the definition of specific regulatory requirements</u>
Various important aspects to be clarified in the contract are being listed: Ownership transfer, handling of energy price risk, insurances, exit regulations, legal succession and unhindered access rights and right

of access, permissibility of different types of financing (Cession, Leasing, Forfeiting) and regulation on intellectual property rights.

The verification process of the previously described assessment criteria is based on proof, assessment and comment. The proof principle answers the question of "What evidence should the assessor look for to assess the criterion?" The assessment queries how the assessor should decide whether the evidence collected (proof) demonstrates that the criterion has been achieved. And finally, the comment section includes supporting comments to assist the assessor in coming to its conclusion.

QualitEE project, EU H2020 project

One of the most visible outcomes of ICP's Investor Ready Energy Efficiency™ Certification for energy efficiency projects can be granted to projects that are developed following the ICP Protocols.

ICP has developed nine **Energy Performance Protocols** covering tertiary and apartment block building energy efficiency projects, complex and simple industry projects and also street lighting projects and has also developed the **ICP Project Development Specification**. This specification brings the details of an energy efficiency project into focus, providing a clear direction with regards to requirements, tools, expectations and quality management.

The interested reader is referred to the different Energy Efficiency Protocols published on the website of ICP for detailed descriptions of the requirements of the protocols and the specifications of the Project Development Specification.

ICP structures the Energy Performance Protocols and the Project Development Specification around the following five categories that, according to ICP, represent the lifecycle of a well-conceived and well-executed energy efficiency project:

- Baselining
    - Core Requirements
    - Rate Analysis, Demand, Load Profile, Interval Data
- Savings Calculations
- Design, Construction, and Verification
- Operations, Maintenance, and Monitoring
- Measurement and Verification (M&V)

The elements considered within these 5 categories are briefly described hereafter:

Baselining – Core Requirements

The purpose of this category is to establish how much energy a building can be expected to consume over a specific, representative period. The elements that are considered in this category that apply to some or all of the Energy Efficiency Protocols are the following: Utility data and baseline period/ Normalised baseline development, energy end-use consumption, weather data, occupancy data, building asset/operational/performance data, retrofit isolation baseline and interactive effects.

Baselining – Rate analysis, demand, load profile, interval data

In addition to the information obtain in the category Baselining- Core Requirements analysis of interval data and the development of load profiles can provide additional information into building performance. When applicable, i.e., when relevant to the project, annual/average daily load profiles should be taken into consideration. These load profiles are being developed based on price schedules (including all elements that are affected by metered accounts) and interval data (e.g., 15-minute, half-hourly) when available.

Savings Calculations

Elements requiring quality assessment in this Savings Calculations category relate to ECM (Energy Conservations Measure) descriptions, dynamic energy modelling (model data, calibration, process description), ECM modelling, ECM calculations (measure calculation tools, calculation data, measure calibration, calculation process description, interactive effects, cost estimates, investment criteria and finally, reporting. Some requirements, i.e., dynamic energy modelling and ECM modelling only apply to large projects.

Design, Construction and Verification

This part of the process focusses on the engineering, implementation and operational performance verification phase of the project. This section deals with requirements or elements related to the operational performance verification plan, the proper operational performance verification and reporting, training and systems manual.

Operations, Maintenance and Monitoring

The purpose of this category, as stated in the Project Development Specification, is to ensure that an appropriate and reasonable practice has been selected and developed to monitor energy system performance, and that corrective action plans have been developed to ensure "in specification" energy performance. To do so, the following elements apply to this category: Operator's Manual, training on OM&M procedures (including performance indicators) and tenant outreach.

Measurement and verification

The M&V activity is about quantifying the savings achieved by comparing the established baseline (under category Baselining) with the energy performance of the project after the implementation of the Energy Conservation Measures. The quantification is normalised in order to reflect the same set of conditions. ICP supports the use of Option A (Retrofit isolation, Key parameter measurement), B (Retrofit isolation, all parameters measurement) and C (Whole facility/building) as defined by the International Performance Measurement & Verification Protocol (IPMVP). The elements considered in this M&V category are the M&V plan and implementation, energy data, regression-based model (IPMVP Option C), estimated parameters (IPMVP Option A) and revised calculations (IPMVP Options A and B).

The verification process of the specifications that are applicable (laid out in the Project Development Specification) is being executed by a Certified Quality Assurance Provider accredited by ICP. It is the QA provider's task to review the outlined elements and project documentation to make sure that the specifications are met.

Annex B Colour label descriptions of the six Themes

This Annex B. provides a description of the defined Colour labels presented in Chapter 3.4.3. The scoring methodology and labelling structure for the six different Themes as described in Chapter 3.4.2. The Desktop Due Diligence Questionnaire (DDDQ). These Themes cover the typical processes and activities that should be taken into consideration when implementing a typical energy efficiency project.

The colour label descriptions of Theme 1. Design of ECM and energy savings calculations provide information on the quality of performance of the design of the ECM, the (consumption) baseline and savings calculations in the light of standards, tools, modelling, reporting and use of qualified experts. For the colour labels yellow, amber and red they indicate which area or areas acknowledge quality issues.

The colour label descriptions of Theme 1. Design of ECM and energy savings calculations are shown hereafter:

(dark green)	Design of ECM, base line and energy savings calculations have been done to the **highest standards,** with adequate tools, modelling and reporting, by **highly qualified independent experts**.
(light green)	Design of ECM, baseline and energy savings calculations have been done to **high standards**, with adequate tools, modelling and reporting, by **highly qualified experts**.
(yellow)	**One of the areas** Design of ECM, baseline or energy savings calculations apply **lower standards**, less effective tools and modelling or reporting while the **other areas** still perform to **high standards.**
(amber)	**Deficient design** of ECM (no or low standard energy audit) with either **poor energy consumption baseline methodology** or **low standard** energy savings **calculations tools**.
(red)	**Deficient design** of ECM (no or low standard energy audit) **with no or poor energy consumption baseline methodology** and **no or low standard** energy savings **calculations tools**.

The colour label descriptions of Theme 2. Implementation of ECM (Energy Efficiency Assets) provide information on the quality of coordination of the implementation of ECM and the level of quality requirements related to the choice of installers/contractors, the implementation process, and the operational performance verification and acceptance process. For the colour labels yellow, amber and red label they indicate which areas are affected by lower quality requirements.

The colour label descriptions of Theme 2. Implementation of ECM (Energy Efficiency Assets) are shown hereafter:

(dark green)	The implementation of ECM is being co-ordinated by **highly experienced 3rd parties**, the choice of installers (contractors), the defined implementation process, the operational performance verification and the acceptance process are **only based** on the **highest quality requirements**.
(light green)	The implementation of ECM is being co-ordinated by **highly experienced 3rd parties** or an **experienced in-house co-ordinator**, the choice of installers (contractors), the defined implementation process, the operational performance verification and the acceptance process are **almost entirely based** on the **highest quality requirements**.
(yellow)	Though the implementation of ECM is being co-ordinated by **highly experienced 3rd parties** or an **experienced in-house co-ordinator**, a **very limited number of low-quality requirements** affect the evaluation of one or more of the following: the choice of installers (contractors), the defined implementation process, the operational performance verification or the acceptance process.
(amber)	Though the implementation of ECM is being co-ordinated by **highly experienced 3rd parties** or an **experienced in-house co-ordinator**, a **certain number of low-quality requirements**

	affect the evaluation of one or more of the following: the choice of installers (contractors), the defined implementation process, the operational performance verification or the acceptance process.
	There is **no co-ordination** of the implementation of ECM and **several low-quality requirements** affect the evaluation of one or more of the following: the choice of installers (contractors), the defined implementation process, the operational performance verification or the acceptance process.

For Theme 3. Maintenance and Operation of the Energy Efficiency Assets the colour label descriptions provide information as to the existence of a Maintenance service agreement and the related quality criteria to ensure optimal functioning of the Energy Efficiency Assets, optimal maintenance performance and minimisation of malfunctioning. For the colour labels yellow, amber and red label the descriptions point either to the areas where there are some quality criteria issues when a Maintenance service agreement is in place, or when there is no Maintenance agreement in place with a third party how this maintenance is being performed then.

The colour label descriptions of Theme 3 Maintenance and Operation of the Energy Efficiency Assets are as follows:

	A Maintenance service agreement with a **specialised 3rd party** is in place based on the **highest quality criteria** ensuring optimal functioning of the Energy Efficiency Assets and minimising the possibilities of suboptimal maintenance performance by the 3rd party and/or malfunctioning of the Energy Efficiency assets.
	A Maintenance service agreement with a **specialised 3rd party** is in place. **Almost all of the highest quality criteria** are in place (but not all) in order to ensure optimal functioning of the Energy Efficiency Assets and minimising the possibilities of suboptimal maintenance performance by the 3rd party and/or malfunctioning of the Energy Efficiency assets.
	1.) A Maintenance service agreement with a **specialised 3rd party** is in place though **some important quality criteria** on **one or more** of the following areas are **not met**: procurement of the Maintenance contractor, avoidance or minimisation of suboptimal functioning of the Energy Efficiency Assets and malfunctions and repairs, or 2.) There is **no Maintenance agreement** in place with a specialised 3rd party but the maintenance and optimal functioning of the EEA is **being done by in-house technical experts with relevant expertise** based on **formal internal maintenance plans**.
	1.) A Maintenance service agreement with a **specialised 3rd party** is in place though a **considerable number of important quality criteria** on one or more of the following areas are **not met**: procurement of the Maintenance contractor, avoidance or minimisation of suboptimal functioning of the Energy Efficiency Assets and malfunctions and repairs. 2.) There is **no Maintenance agreement** in place with a specialised 3rd party but the maintenance and optimal functioning of the EEA is **being done by in-house technical experts** with relevant expertise **without formal internal maintenance plans**.
	1.) A Maintenance service agreement with a **specialised 3rd party** is in place though based on **very poor-quality criteria** related to the procurement of the Maintenance contractor, to the avoidance or minimisation of suboptimal functioning of the Energy Efficiency Assets and malfunctions and repairs. 2.) There is **no Maintenance agreement** in place with a specialised 3rd party and maintenance and functioning of the EEA is not being done according to a maintenance schedule but **on demand or when malfunctions are observed.**

For Theme 4. Monitoring of the Energy Efficiency Assets and their energy consumption the colour label descriptions indicate whether there is monitoring in place including relevant KPI, a methodology for tracking, analysing and assessing performance, adequate tools and systems and adequate training of operating staff. When the monitoring does not include all the above-mentioned elements the descriptions point to possible elements missing.

The colour label descriptions of Theme 4. Monitoring of the Energy Efficiency Assets and their energy consumption are as follows:

	Monitoring of the Energy Efficiency Assets and their energy consumption is **in place** including relevant Key Performance Indicators, a methodology for tracking, analysing and assessing performance, adequate tools and systems and adequate training of operating staff.
	Monitoring of the Energy Efficiency Assets and their energy consumption is **in place** including relevant Key Performance Indicators, a methodology for tracking, analysing and assessing performance, adequate tools and systems and adequate training of operating staff. Nevertheless**, tools and systems do not include** either automated fault detection and diagnostic tools or a Building Management System.
	Monitoring of the Energy Efficiency Assets and their energy consumption is **in place** but does **not include one of the following**: relevant Key Performance Indicators, a methodology for tracking, analysing and assessing performance, adequate tools and systems (either data collection system or energy management system), or adequate training of operating staff.
	Monitoring of the Energy Efficiency Assets and their energy consumption is **in place** but does **not include more than one of the following**: relevant Key Performance Indicators, a methodology for tracking, analysing and assessing performance, adequate tools and systems (either data collection system or energy management system), or adequate training of operating staff.
	There is **no monitoring** of the Energy Efficiency Assets in place or the **monitoring includes only one or two of the following:** relevant Key Performance Indicators, a methodology for tracking, analysing and assessing performance, adequate tools and systems (either data collection system or energy management system), or adequate training of operating staff.

The colour label descriptions of Theme 5. Measurement and Verification of the energy savings highlight whether a comprehensive M&V approach or a simplified M&V approach or no M&V approach (red label) has been defined and whether the M&V approach has been defined following any certified M&V protocol and/or serviced by a certified M&V-expert.

The colour label descriptions of Theme 5. Measurement and Verification of the energy savings are the following:

	A **comprehensive Measurement & Verification approach** has been defined following any **certified M&V protocol** such as IPMVP or ISO50015, serviced or supervised by an **independent M&V-certified expert**.
	A **comprehensive Measurement & Verification** approach has been defined following any **certified M&V protocol** such as IPMVP or ISO50015, serviced or supervised by an **in-house or contractor's M&V-certified expert**.
	1.) A **comprehensive Measurement & Verification** approach has been defined, a.) following a certified **M&V protocol** such as IPMVP or ISO50015 but **not supervised** by any M&V-certified expert or b.) **not following a certified M&V protocol** though supervised by a **certified expert**, or 2.) a **simplified M&V approach** has been defined, following a **certified M&V protocol** and supervised by a **certified expert**.
	1.) A **comprehensive Measurement & Verification approach** has been defined though **not following a certified M&V protocol** such as IPMVP or ISO50015 and **not serviced or supervised** by a M&V-certified expert, or 2.) A **simplified M&V approach** has been defined, but either **not following a certified M&V protocol** or **not supervised** by a certified expert.
	There has been **no Measurement & Verification approach** defined.

The colour label descriptions of Theme 6. Communication with and training (awareness) of users and/or occupants indicate whether or whether not a comprehensive approach for collection, verification and implementation of users' requirements has been put in place as well as a user information process and an energy awareness program.

The colour label descriptions of Theme 6. Communication with and training (awareness) of users and/or occupants are the following:

Dark green	A **comprehensive approach** for collection, verification and implementation of users' requirements has been put in place as well as a **user information process** on the implemented energy efficiency improvements and an **energy awareness program** to optimise user and occupant's energy awareness and behaviour.
Light green	A **comprehensive approach** for collection, verification and implementation of users' requirements with a **minor flaw** has been put in place, a **user information process** on the implemented energy efficiency improvements has been put in place as well as an **energy awareness program** to optimise user and occupant's energy awareness and behaviour.
Yellow	1.) **No user information process** on the implemented energy efficiency improvements has been put in place, or 2.) An **approach** for collection, verification and implementation of users' requirements **with several flaws** has been put in place, as well as a **user information process** on the implemented energy efficiency improvements and an **energy awareness program** to optimise user and occupant's energy awareness and behaviour.
Orange	One of the **following communication and awareness programs is missing**: comprehensive approach for collection, verification and implementation of users' requirements or an energy awareness program to optimise user and occupant's energy awareness and behaviour.
Red	**No comprehensive approach** for collection, verification and implementation of users' requirements has been put in place and **none or only one of the following programs might be in place:** a user information process on the implemented energy efficiency improvements or an energy awareness program to optimise user and occupant's energy awareness and behaviour.