CERtuS

Grant Agreement N. IEE/13/906/SI2.675068

Co-funded by the Intelligent Energy Europe Programme of the European Union

Cost Efficient Options and Financing Mechanisms for nearly Zero Energy Renovation of existing Building Stock

PUBLISHABLE REPORT

The Promotion / Dissemination Project on Integrated Initiatives of the Executive Agency for Small and Medium-sized Enterprises (EASME) CERtuS - Cost Efficient Options and Financing Mechanisms for nearly Zero Energy Renovation of existing Building Stock - has received funding from the EU – IEE EASME under the Grant Agreement number IEE/13/906/SI2.675068
This Publishable Report is part of the Final Technical Implementation Report of IEE/EASME European Project CERtuS
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Published in April 2017 by the CERtuS project consortium
Reprinted in February 2018 by ENEA

ISBN: 978-88-8286-374-6

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1 BACKGROUND TO THE CERTUS PROJECT

1.1 OVERVIEW OF THE EU ENERGY POLICY IN THE BUILDING SECTOR

The energy efficiency of buildings is one of the most relevant and strategic issues that are debated in recent years in European and global level, considering that buildings are responsible for more than 40% of world global energy use and as much as 30% of global greenhouse gas emissions [1].

The European Union has become the promoter of programs, guidelines and Directives, such as the 2002/91/EC and 2010/31/EU on the energy performance of buildings, 2006/32/EC on energy end-use efficiency and energy services and, the 2012/27/EU on energy efficiency, in order to put in place instruments, criteria and harmonized and shared solutions on the specific issue of the increase of energy efficiency of buildings, existing and new.

All the mentioned Directives represent cornerstones of the Energy Efficiency. Since 2010, the recast of 2010/31/EU (EPBD) introduced the concept of nZEB at European level: 'nearly zero-energy building' means a building that has a very high energy performance. The nearly zero or very low amount of energy required should be covered to a very significant extent by energy from renewable sources, including energy from renewable sources produced on-site or nearby. The EPBD requires the final national detailed definition under the responsibility of each European Member State.

According to the recast of the EU Directive on EPBD by the end of 2020 all new buildings should be nearly Zero Energy; the deadline is even sooner - by the end of 2018 - for the existing buildings occupied and/or owned by public authorities. It is obvious that new buildings have limited impact on the overall energy reduction as they represent just a small part of the building stock. From the other hand, existing buildings can often be improved at far lower cost than would be required to demolish and erect new buildings. If energy consumption is high in the existing buildings, the potential for savings is proportional and this constitutes a great opportunity for energy efficiency improvements. It is equally true that is more difficult to apply the concept of nZEB in existing buildings with respect to the new buildings. The performance of building is a sum of the following factors, which in the existing buildings are already defined: (i) building envelope characteristics; (ii) HVAC-and BAS-systems, if exist; (iii) the building use and users' behavior; (iv) the building type; (v) location and climate conditions; (vi) maintenance and management. The key issue is how the individual factors perform and how well they are integrated to perform together. As mentioned above there are several parameters to consider when working with existing buildings.

In existing buildings all or some of these factors can be improved, but there are limitations and obstacles, caused by the technical reasons, (e.g. lack of proper information, such as consumption figures or deficiencies on measurements) economic reasons and/or organisatory / management reasons.

More difficulties arise when the renovation options interfere with preservation requirements of historic buildings as apposite authorities set limitations.

For that motive, energy efficiency and application of nZEB on historic buildings is a special case and it can be very difficult, but with the implementation of energy efficiency measures adapted to their specific characteristics it is not impossible.

1.2 WHERE WE STAND: THE NZEB IN EUROPE AND SPECIFICALLY IN THE FOUR CERTUS COUNTRIES

According to the more recent report of national applications of the nZEB definition [2] there is not a common and homogeneous national progress within the Members States. Furthermore, the progress in developing and setting the national application of the nZEB definition in most countries, as Southern European countries has been a slow process. As claimed by the report above about 40% of the Member States did not have, at that date, a detailed definition of the nZEB, while 60% of them had laid out their detailed nZEB description, although in different level of definition. The report shows also that the Central and Northern Member States are more advanced in implementing the articles within the Directive. There is a gap between Southern European countries and Central and Northern Member States in order to catch up their progress toward nZEB.

The current status of national nZEB definitions of the four CERtuS countries is the following:

In Italy, the Ministerial Decree of 26 June 2015 completes the transposition of the European Directive EPBD 2002/91/CE, defines the requirements of nZEB and set the new minimum requirements, to be in force since October 2015. Existing and new buildings are characterized by very high energy performance and very low energy requirements covered to a significant extent by energy from renewable sources, produced within the pertinent areas of the building (on-site and not nearby).

In this legislative measure it is also introduced a new calculation method for the energy performance, based on the comparison with a reference building having the characteristics set in the decree. All energy use needed to comply with the standard use of the building is included in computation of the energy performance of the building, which is referred to different classes. The format for technical project reports is also defined, relative to new and nZEB relevant retrofitting and technical installations [3].

In Greece, the recently published law, N.4342/15 transposes the Energy Efficiency Directive 2012/27/EU in the national legislation. The levels of nZEB and the expected contribution of RES is under development.

In Portugal, the national legislation (Decree-Law 118/2013) defines nearly Zero Energy Buildings as buildings with high energy performance and where the energy needs are mainly ensured by energy from renewable sources, produced on site or nearby.

In such Decree-Law it is also determined that a nZEB must have: Efficient component compliant with the most demanding limit levels of economic viability that may be

obtained by applying the methodology of optimal cost, differentiated for new and existing buildings and for different types; Local ways of capturing renewable energy covering a large part of the remainder of the predicted energy requirements, preferably in the same building or in the same plot of land of the building or in addition, in common use infrastructures as close as possible to the place where it is not possible to meet the needs of renewable energy resource.

The Decree-Law 118/2013 determines that a methodology of optimal cost and the levels of minimum energy performance must be defined in the national plan for rehabilitation of buildings and be approved by the government members in charge of the areas of energy, regional planning and finances. However, such plan was not yet defined, and therefore there are not yet any levels of energy performance defined.

Spain has not yet formulated the definition of nZEBs. The detailed definition is expected between 2016 and 2018 and, even though implementation will not become compulsory until December 2020, it may be applied on a voluntary basis and will serve as a benchmark for incentives.

A revision of the Spanish technical building code, foreseen to 2018, will update technical regulations on energy performance and will introduce the definition of nZEBs. It will establish the obligation to comply with corresponding requirements in all buildings constructed from 31/12/2018 for buildings owned by public authorities and from 31/12/2020 for all other buildings.

1.3 THE ENERGY RENOVATION AND ITS RELEVANCE IN PUBLIC BUILDINGS

In the EPBD recast it is requested that “the public sector in each Member State should lead the way in the field of energy performance of buildings” and “buildings occupied by public authorities and buildings frequently visited by the public should set an example”.

Energy efficient renovation of public buildings and other options, as the nZEBs, for high energy performance show that energy innovation through the deep envelope refurbishment and contribution of RES is possible; public buildings can be forerunners and “shining examples” in it. The impact of the innovative technologies and systems, as the indoor comfort can be visualized to every day users and visitors of public buildings and they can be repeated also in the private sector. In addition, it is also question how taxpayer’s money has been used.

The energy renovation of the public building stock opens the way for ambitious large-scale renovation of the entire existing building stock. Its role can be symbolic, but it can generate a spillover effect.

1.4 FINANCING THE ENERGY RENOVATION OF PUBLIC BUILDINGS

The investments on the existing buildings tend to focus on measures with short and medium payback period (less than 10 years) which usually generate less than 30% energy savings. However, according to Bullier and Milin [4] ambitious energy and

climate policies require saving up to 80% energy in buildings, which is only possible with structural interventions such as insulation of facades, or replacement of windows. These deep renovations have a payback time between fifteen and forty years in the EU, at current energy prices. This varies across countries and types of buildings. The payback refers to energy investment costs (without general refurbishment measures), with stable energy prices.

[1] UNEP SBCI, Buildings and Climate Change, http://www.unep.org/sbci/pdfs/SBCI-BCCSummary.pdf

[2] Concerted Action, Energy Performance of Buildings, Hans Erhorn, Heike Erhorn – Kluttig, "Overview of national applications of the nealy Zero Energy Building definition, Detailed report", April 2015, http://www.epbd-ca.eu/wp-content/uploads/2016/01/Overview_of_NZEB_definitions.pdf

[3] http://www.iea.org/policiesandmeasures/pams/italy/name-153231-en.php

[4] Adrien Bullier & Christophe Milin, Alternative Financing Schemes for Energy Efficiency in Buildings, in ECEEE. SUMMER STUDY PROCEEDING 795, 796 (2013)

2 THE CERTUS PROJECT

2.1 CERTUS PROJECT IN BRIEF

Southern European countries undergo a severe economic crisis. This has a profound negative effect on energy savings and the progress towards achieving 20-20-20 goals. Energy saving investments have been impeded in the public sector because the priorities are now different.

More specifically, the crisis hinders the compliance to the latest Energy Efficiency Directive, demanding strict energy efficiency measures for the public sector. Investments required to renovate public buildings and achieve nearly zero energy consumption have long payback times. Simultaneously the EPBD recast sets out that Member States shall draw up national plans for increasing the number of nearly zero-energy buildings and the public sector must be a leading example.

The Energy Efficiency Directive 27/2012 further requests that the Member States shall encourage public bodies at regional and local level governed by public law to adopt an energy efficiency plan with specific energy saving and efficiency objectives regarding existing buildings. Thus, the 20-20-20 commitment of the Member States and the obligation to implement the aforementioned Directives call for intensified actions in energy efficiency in public buildings which become extremely difficult under the current economic austerity. Moreover, banks have limited resources and ESCOs and third parties hesitate to be involved in financing in the public sector because of disincentives such as the complex administrative procedures and current budget management of public buildings which need reform.

The objective of the proposed action is to help stakeholders gain confidence in such investments and initiate the growth of this energy service sector. Municipalities, energy service companies and financing entities from Italy, Greece, Portugal and Spain are involved in this project.

CERtuS was a project aiming to producing representative deep renovation projects that will act as models for replication. Twelve buildings in four municipalities of each targeted country were selected. The partners adapted existing energy service models and procedures and developed financing schemes suitable for the 12 projects. CERtuS partners were investigating opportunities and instruments such as combination of funds coming from different sources, both private and public ones. Such a combination will alleviate the burden from the public resources due to the inflow of private funds whilst simultaneously will leverage private capitals by reducing risks, payback times and thus making the overall investment more attractive. Nevertheless, the aim of the proposed project was to maximize the inflow of private funds.

Another key issue is the energy service market, which is not as developed in the southern Member States as is in other parts of EU, especially regarding the ESCOs. Additionally, most energy service providers as for example the ESCOs, operate on well-tried contracts such as EPC (Energy Performance Contracting) or EEO (Energy Efficiency Obligation). These contracts, however, have not been used up to now for nZEB deep renovations.

In order to provide the financing and energy service options to be implemented and replicable obstacles related with the municipal infrastructure and mainly with the administration, accounting and budget management will be addressed and proposals will be made to the competent bodies of Central Government.

A very important issue to deal with in CERtuS is the capacity building in Municipalities - not only for the participating ones but in a very large target group – which will facilitate replication of the renovation examples to be produced and especially it will support local and regional Governments to prepare plans for energy efficiency and energy savings and facilitate the implementation of EED (article 5.7(a)).

CERtuS have worked with representative Municipalities in size, population and building stock. In Mediterranean Member States as for example in Italy, most of public buildings has a historic value but is not monumental. For these buildings there are legislation requirements that any renovation activity needs to comply with. It was important for CERTUS project to take in consideration these buildings and work out nZEB renovation schemes and financing mechanisms. The results on this issue are already very important because a large pool of existing buildings will not be exempted from the Energy Efficiency Plans of the member state. Nowadays, the successful implementation of Directive 2010/31/EU concerning the transformation of public buildings in nZEB, largely depends on whether or not Mediterranean Members States take in consideration the refurbishment of the historical buildings. Considering that the EU Mediterranean countries have a building stock of 70% built before the laws on energy efficiency and it is often obsolete and needs urgent and necessary energy efficiency interventions and that, big part of this public building stock is historic, with law restrictions, it is obvious that if we exclude this public building stock, which is historic, the Directive may not reach the expected results.

CERtuS partners have created materials suitable to support the intensive communication plan of the Project. The plan included four workshops with B2B sessions targeted to municipalities, ESCOs and financing entities. These actions have been complemented by four training activities targeting municipal employs and the participation in international events targeting all 3 stakeholders. We are confident, and we expect that after on the end of CERtuS action will have a significant impact by triggering investments in innovation to achieve nZEB and to uptake the ESCO market in Southern European Member States.

2.2 OBJECTIVES OF CERTUS PROJECT AND ACHIEVED IMPACTS

The objectives and future CERtuS effects and purposes for the upcoming years (2017-2020), are:

- ✓ *To create conditions so that more municipalities, financing institutions and third party contractors develop projects of nZEB renovations. The goal is to create an avalanche effect. The CERtuS model projects will act as good examples to demonstrate the feasibility of such renovation projects.*

- ✓ *To stimulate the inflow of more private funds in nZEB renovation supporting the southern Member States to fulfil obligations towards EPBD recast and EED Directives.*
- ✓ *To stimulate the development of even more financial schemes to accelerate the implementation of the EPBD recast and EED Directives in the southern European Member States.*
- ✓ *To stimulate the uptake of ESCo´s market in southern European Member States.*
- ✓ *To facilitate the implementation of the Energy Efficiency Directive.*

The vision of CERtuS to develop and demonstrate, through its pilots, the feasibility of cost-effective and high-performance renovation of existing public building stock is based on a complex and, sometimes, gradual package of financial mechanisms combining market and public instruments. Financial institutions and other third party investors and ESCOs represent key stakeholders for sustainable energy projects.

2.3 CERTUS PROJECT NZEB DEFINITION:

As none of the involved countries have had at the date of the CERtuS proposal submission (2013) a detailed definition on the nZEB, the CERtuS team followed the IEE definition[1] and prepared the renovation options of the 12 representative model cases with the following targets:

- 75% - 80% improvement of the overall energy efficiency or to the levels indicated by the national regulations for nZEB if better
- Use of RES in the interval of 70% - 90% of the current heat, cool and electricity demand

The aim of the CERtuS action was to obtain an optimal renovation design creating comfortable conditions, without compromising the air quality and comfort conditions, (temperature, humidity, airflow and radiant sources within acceptable range) as these are critical to the productivity of the public buildings users.

[1] Pau Garcia, EASME- Unit B1Energy, *Can ambitious NZEB targets be reached?*

3 CERTUS APPROACH AND APPLIED METHODOLOGY

3.1 CERtuS TECHNICAL APPROACH AND CONCEPT

The energy efficiency improvement of the existing public building stock leads to a significant reduction of the energy demand. This can be done by using energy efficient appliances lighting, heating, cooling, controls etc., and by simultaneous energy production of renewable sources. As in every renovation projects, in order to reach nZEB standards, the starting point is the condition of the present target building.

What is the actual energy consumption level before renovation, what is a realistic and planned new consumption level, what kind of measures are needed to reach the goal and what investments it will required? Time to recoup the funds expended in an investment (payback time) should also be considered, as the investments needed to achieve the planned energy consumption level can be too high compared with the achievable energy savings. The financing of investments is another very essential issue for a criterion of renovation design.

Energy-related renovation is, mostly and mainly, a compromise between the technical solutions and available financial direct or indirect resources

3.2 CERtuS TECHNICAL DOCUMENTED PROCESSES AND PROCEDURES

In energy renovation design process of the CERtuS pilots, the first step was to define the actual condition of the building by performing an energy check. In the majority of the twelve cases the consumption figures from at least 3 previous years as well as building documents and information about structures and equipment have been examined. This was not always possible due to missing data or documents that have not been updated. Most often we only knew the total consumption of electricity but its distribution for the different uses (lighting, HVAC systems etc.) could not be measured or was unknown. The heating energy consumption, heat losses and their distribution for different elements (i.e.: windows, walls, etc.) have been evaluated using the existing data and calculation tools. It was also useful estimating the optimum consumption under prevailing conditions – what can be achieved with the existing systems and what was the goals of building titleholder. Especially some documents (existing drawings, previous data, etc.) of the historic CERtuS buildings were not available, or was inaccurate or included incorrect and dated information. All the documents have been updated during the renovation project matching the recent situation and have been converted also into electronic format. The documentation of the renovation project was an essential topic.

In the CERtuS energy-related design the goal has been defined and compared with the recent situation – what was the realistic saving potential and what measures dealing with building envelope and heating, cooling, ventilation and building automation system (if this exists) could be done.

It was essential to determine the titleholder requirements. To meet these requirements, it was necessary to find various technical solutions to realize them and also calculate the investments needed and the payback time.

Often the twelve renovation projects should be phased for several years on, so it was important to take the right measures at the right time. Indeed, the renovation measures have been divided into period of longer time, when needed. Also the order of the renovation was very important – what must be done at the first stage and what later. This is critical especially in nZEB-buildings, when the financing resources are limited, and the goal is to have optimal energy efficiency.

There were many factors affected the performance and the energy efficiency of the CERtuS pilots and the buildings generally and those factors influence each other. We can speak about "renovation debt" which means how much be invested so that the performance level of a building would be in a proper level, (about at least 70-80 % of the performance level of a new building). If there is no available funding to increase the performance level, the life cycle of a building will be shortened, and in the worst case the building must be demolished. That´s why the short- and long-time maintenance works of CERtuS pilots have been planned very carefully.

3.3 CERtuS TECHNICAL STEPS OF AN ENERGY RELATED RENOVATION PROJECT

The CERtuS pilot renovation was the result of a process, with the aim of achieving a good indoor environment and optimizing energy consumption. All measures concerning building envelope as well as technical systems and equipment was served to this goal. There was not compromise between indoor conditions and energy savings – the aim was to optimize the use of energy, always ensuring healthy and safe indoor environments.

- ✓ **Energy audit and condition survey:**
  - **Collection and analysis of available documents and other information**
  - **Execution of additional measurements that may be needed (air tightness test, thermography, air flow measurements etc.)**
  - **Renovation plans based on life-cycle evaluation and sensible payback times**
  - **Identifying interventions with the best cost/effectiveness ratio and final design**
- ✓ **Realization of the energy-related renovation**
  - **Building Commissioning tools in each stage of the project: performance as designed**
- ✓ **Evaluation and verifying the results**

3.4 CERtuS SPECIFICATIONS FOR DEEP RENOVATION - PLANNING AND DESIGNING STRATEGY

The CERtuS pilot buildings have been optimized in many different areas starting with the building design (architecture) which certainly can be influenced less strongly during the renovation of an existing building. Next step was looking at the thermal quality of the building envelope and detailed solutions for avoiding thermal bridges and ensuring airtightness to the choice and quality of the building services systems for heating, cooling, ventilation, lighting and building automation. Energy efficient public buildings equipment has been chosen and energy has generated from renewable energy sources to compensate the use of conventional energy forms.

It was essential to consider sustainability and energy efficiency of the twelve buildings at the very start in order to establish the key targets. Ambitions and intentions was stated in the building programme, containing a finite number of clear and manageable high level objectives. Objectives regarding building suitability, energy demand and building materials have been emphasised and put into specific terms. Experience has taught us that if goals are not set at an early stage, they tend to either be forgotten or be left out due to pressures from budget or work schedule.

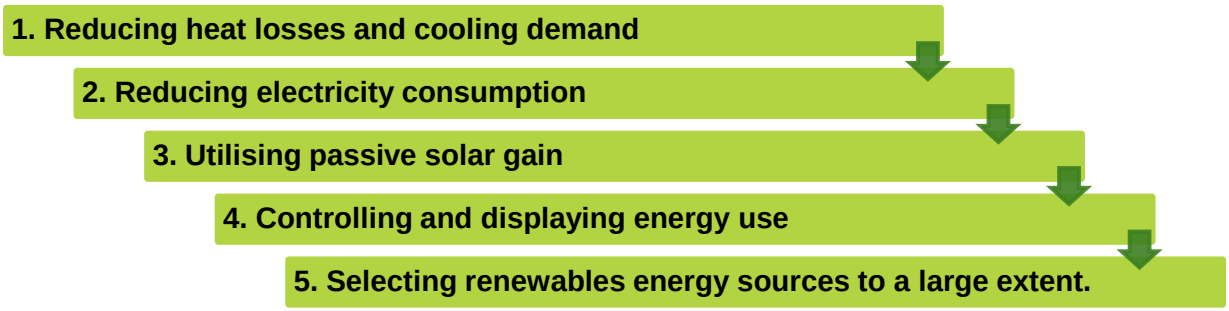
The professional knowledge of architects and engineers has been combined in the design phase, estimating how different building structures and envelope designs influence the indoor climate and energy use for heating, cooling, ventilation and lighting. Climatic analysis revealed the potential for utilising available solar, light and wind resources. Concepts have been tested by means of sketch models to assess the design and adjust it to the situation, before gradually developing the final design.

Environmental simulation of each building performance was done at the start and at the end of the design process. Any weak points in the performance of the design have been 'fixed' by replacing heating, cooling and by adding shades, vents, fans, panels, etc. This is because at the end of the design process it is too late to incorporate various passive techniques, which should be considered in the early, most conceptual stages of the building design process.

Essentially, the interdisciplinary CERtuS planning process was based on the idea of an optimised team work, which started in the pre-project stage to make a clear definition of the CERtuS design goals. Furthermore, there was a qualified design process management, and tools for analyses and assessments have been applied, taking into account a variety of options from the very start. The knowledge of different specialists (i.e. conservators of historic / listed buildings) have been introduced at the early stage.

3.5 CERtuS TECHNICAL RECOMMENDATIONS

In aiming to reduce the energy consumption, CERtuS team followed the strategy of the below five steps:



In other words: the starting point is application of energy efficient measures to reduce energy demand, and then supply the remaining demand utilising renewable energy sources.

Designers should repeatedly estimate how different plan lay-out, structure and envelope design influence the indoor climate and energy use. A major challenge is handling goal conflicts. Measures must be balanced to reach several goals, e.g.:

- Exploitation of daylight will benefit users' contentment and well-being. At the same time exploitation of daylight will reduce the consumption of electric power for artificial lighting. On the other hand, an extended use of glazing may cause a higher demand for heating and possibly cooling energy.
- Air quality and comfort temperature will benefit users' contentment and well-being. A high performance ventilation system is thus required. On the other hand, energy consumption for the system should be kept as low as possible.
- Adequate acoustics will benefit users' contentment and well-being. The desired reverberation time will vary according to functions, and it may be contradictory considerations to take into account regarding multi-functional space. The placement of absorbers must be considered in relation to the benefit of thermal mass stabilising internal temperatures.

Different solutions have different strengths and weaknesses, and the project team has to optimise the solution as a whole, and not on a component-by-component basis. From the assessment of different solutions, the project team identifies parameters that make a difference, and gain an increasing awareness of the environmental impacts of the design. The success criteria should be related to achieving the objectives and intentions stated in the program.

3.6 CERTUS IMPLEMENTATION OF NZEB PUBLIC BUILDINGS: THE EXPERIENCE OF THE MUNICIPALITY OF MESSINA, ITALY

Messina, the first Italian port for passenger transport, is located at the North-Eastern front of Sicily. The selected buildings for CERtuS are: the Zanca Palace housing the City Hall, the Palace of Culture and the Satellite Palace. The first building is listed and governed by special regulations, constraining severely the renovation options.

Renovation measures: External insulating plaster, (internal insulation in Palace of Culture only), efficient windows, natural ventilation, VRV for heating and cooling, LED lighting, BEMS, roof integrated photovoltaics. Energy savings amount respectively to 62%, 57% and 91% of the three buildings' current consumption for heating, cooling, lighting and hot sanitary water.

ZANCA PALACE, listed building	
Building Type	City hall/ multiple purpose use
Year of Construction	1914
Area / Volume	13,500 m^2 (about 7.000 m^2 to floor) / 95.000 m^3

ENERGY EXPENDITURE PRE- AND POST-RENOVATION			
Energy consumption pre-renovation (kWh/year)	Energy consumption pre-renovation/m^2 (kWh/m^2 yearly)	Energy consumption post renovation (kWh/year)	Energy consumption post renovation/m^2 (kWh/m^2 yearly)
1,404,039	105	532,254	39

Palace of Culture "Antonello Da Messina"	
Building Type	Multifunctional center
Year of Construction	1975
Area / Volume	10,300 m^2

ENERGY EXPENDITURE PRE- AND POST-RENOVATION			
Energy consumption pre-renovation (kWh/year)	Energy consumption pre-renovation/m^2 (kWh/m^2 yearly)	Energy consumption post renovation (kWh/year)	Energy consumption post renovation/m^2 (kWh/m^2 yearly)
885,469	86	179,872	17

SATELLITE PALACE	
Building Type	Municipal Offices
Year of Construction	1970
Area / Volume	6,870 m^2 (about 1,350 m^2 to floor) / 18,550 m^3

BaENERGY EXPENDITURE PRE- AND POST-RENOVATION			
Energy consumption pre-renovation (kWh/year)	Energy consumption pre-renovation/m^2 (kWh/m^2 yearly)	Energy consumption post renovation (kWh/year)	Energy consumption post renovation/m^2 (kWh/m^2 yearly)
340,637	50	32,068	4.66

3.7 CERtuS IMPLEMENTATION OF nZEB PUBLIC BUILDINGS: THE EXPERIENCE OF THE MUNICIPALITY OF ALIMOS, GREECE

Alimos, the birth place of Thucydides, father of history, is a medium sized coastal city in the Athens metropolitan area. The CERtuS buildings are the City Hall, the Environmental Services and the Municipal Library.

Renovation measures: LED lights, VRV for heating and cooling, HRV for ventilation, shading, night-time ventilation, BEMS, roof integrated photovoltaics in all buildings and pellet burner in the Library. Energy savings, for heating, cooling, lighting and sanitary hot water, reach 92%, 100% and 87% for the three buildings respectively. Additional external insulation and window replacement would increase the payback period, thus making financing difficult without significant public financial support.

Alimos City Hall	
Building Type	City Hall
Year of Construction	1986
Area / Volume	1,302 m2 /3,612 m3

ENERGY EXPENDITURE PRE- AND POST-RENOVATION			
Energy consumption pre-renovation (kWh/year)	Energy consumption pre-renovation/m² (kWh/m² yearly)	Energy consumption post renovation (kWh/year)	Energy consumption post renovation/m² (kWh/m² yearly)
111,965	102	8,795	8

Municipal Library	
Building Type	Library
Year of Construction	1984
Area / Volume	611 m² /2,185 m³

ENERGY EXPENDITURE PRE- AND POST-RENOVATION			
Energy consumption pre-renovation (kWh/year)	Energy consumption pre-renovation/m² (kWh/m² yearly)	Energy consumption post renovation (kWh/year)	Energy consumption post renovation/m² (kWh/m² yearly)
122,195	241	15,148	29,9

Municipal Envoronmental Offices	
Building Type	Municipal Offices
Year of Construction	1986
Area / Volume	446 m² /1,518 m³

ENERGY EXPENDITURE PRE- AND POST-RENOVATION			
Energy consumption pre-renovation (kWh/year)	Energy consumption pre-renovation/m² (kWh/m² yearly)	Energy consumption post renovation (kWh/year)	Energy consumption post renovation/m² (kWh/m² yearly)
30,160	97	0	0

3.8 CERTUS IMPLEMENTATION OF NZEB PUBLIC BUILDINGS: THE EXPERIENCE OF THE MUNICIPALITY OF COIMBRA, PORTUGAL

Coimbra, the 'City of Knowledge', is located in the centre of Portugal between Lisbon and Porto. The selected buildings for CERtuS are the City Hall, the House of Culture and the Elementary School of Solumn. The City Hall is listed and protected by UNESCO.

Renovation measures: Efficient air conditioning, LED and T5 lamps, special photovoltaic tiles for the roof of the City Hall and roof integrated photovoltaic panels for the other two buildings. There is limited potential for building envelope improvement. Energy savings for heating, cooling, lighting and sanitary hot water, reach 72%, 97% and 98% for the three buildings respectively.

Coimbra Town Hall, listed building.	
Building Type	Town Hall / Multiple functions of public utility
Year of Construction	1876-1879
Area / Volume	5,880 m^2 / 40,575 m^3

ENERGY EXPENDITURE PRE- AND POST-RENOVATION			
Energy consumption pre-renovation (kWh/year)	Energy consumption pre-renovation/m^2 (kWh/m^2 yearly)	Energy consumption post renovation (kWh/year)	Energy consumption post renovation/m^2 (kWh/m^2 yearly)
350,206	60	100,606	17

Municipal House of Culture	
Building Type	Library, auditorium, art gallery
Year of Construction	1876-1879
Area / Volume	5,880 m^2 / 40,575 m^3

ENERGY EXPENDITURE PRE- AND POST-RENOVATION			
Energy consumption pre-renovation (kWh/year)	Energy consumption pre-renovation/m^2 (kWh/m^2 yearly)	Energy consumption post renovation (kWh/year)	Energy consumption post renovation/m^2 (kWh/m^2 yearly)
565,980	43	92,230	7

Elementary school of Solumn	
Building Type	Elementary school
Year of Construction	In the 1950s
Area / Volume	1,655 m^2 / 6,269.21 m^3

ENERGY EXPENDITURE PRE- AND POST-RENOVATION			
Energy consumption pre-renovation (kWh/year)	Energy consumption pre-renovation/m^2 (kWh/m^2 yearly)	Energy consumption post renovation (kWh/year)	Energy consumption post renovation/m^2 (kWh/m^2 yearly)
47,524	29	15,336	9

3.9 CERTUS IMPLEMENTATION OF NZEB PUBLIC BUILDINGS: THE EXPERIENCE OF THE MUNICIPALITY OF ERRENTERIA, SPAIN

Errenteria, a medieval Basque town, is located close to the French borders. The selected buildings are: the City Hall, Kapitain Etxea housing the archives of the Municipality and the Lekuona Industrial Building. While the first two are listed, the third one is partially only.

Renovation measures: Internal insulation and efficient windows (in Kapitain Etxea), condensing boiler, biomass pellets, VRV for cooling, heat recovery, LED lights, daylight sensors. Energy savings, for heating, cooling, lighting and sanitary hot water, in the three buildings reach 33%, 65% and 11% respectively.

Errenteria Town Hall	
Building Type	Town Hall
Year of Construction	1603 -2000
Area / Volume	2,961 m^2 / 11,418 m^3

ENERGY EXPENDITURE PRE- AND POST-RENOVATION			
Energy consumption pre-renovation (kWh/year)	Energy consumption pre-renovation/m^2 (kWh/m^2 yearly)	Energy consumption post renovation (kWh/year)	Energy consumption post renovation/m^2 (kWh/m^2 yearly)
279,160	94	187,832	63

Kapitan Etxea	
Building Type	Municipal archive
Year of Construction	1650 (aprox.)
Area / Volume	395 m^2 / 1,362 m^3

ENERGY EXPENDITURE PRE- AND POST-RENOVATION			
Energy consumption pre- renovation (kWh/year)	Energy consumption pre-renovation/m^2 (kWh/m^2 yearly)	Energy consumption post renovation (kWh/year)	Energy consumption post renovation/m^2 (kWh/m^2 yearly)
68,985	175	24,067	61

Lekuona	
Building Type	industrial
Year of Construction	1963
Area / Volume	4,406 m^2 / 20.328 m^3

ENERGY EXPENDITURE PRE- AND POST-RENOVATION			
Energy consumption pre- renovation (kWh/year)	Energy consumption pre-renovation/m^2 (kWh/m^2 yearly)	Energy consumption post renovation (kWh/year)	Energy consumption post renovation/m^2 (kWh/m^2 yearly)
332,279	75	296,534	67

3.10 CERtuS Approch and Methodology supporting the decision making process and the economic evaluation of energy related renovation projects

During the CERtuS action, a methodology to support the decision making process and the evaluation of the energy related renovation projects has been developed. This methodology has been employed by CERtuS team and has also confirmed how the specific knowledge and competence of each partner of the project were essential for the good success the various initiatives of the context.

First and foremost, Municipalities played such an important role, as their duties beyond the scope of the CERtuS project relate to:

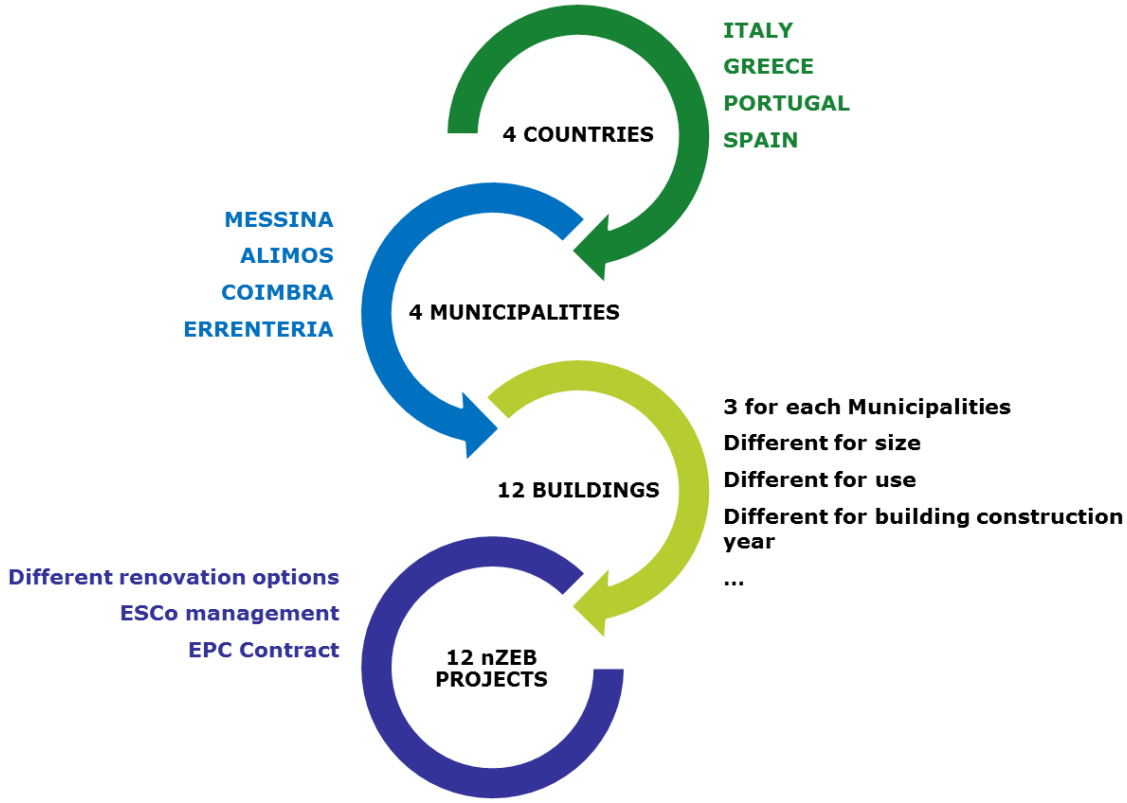
- Sharing and becoming active part in the achievement of the goals of energetic and environmental policies
- Coordinating and realizing the various activities finding out the best procedures of development
- Actively involving other stakeholders and public institution to develop the project
- Researching, selecting and identifying the proper instruments and financing modalities
- Improving the quality of services and citizens life quality
- Promoting social awareness and consciousness of energy and environmental issues

However, many municipalities are not always able to carry out such activities autonomously because of structural limits and, especially in smaller realities, because of the lack of the needed competences.

During the project, many obstacles which often arise while working on public properties emerged:

- Lack of grant resources to finance necessary interventions
- Financial constraints of public entities
- Lack of knowledge of the energy consumption data of public buildings or difficulty to access to the same data, hindering a proper identification of priorities and intervention areas
- Difficultly of identifying ordinary and extraordinary maintenance costs
- Difficulty in the estimation of the baseline and in the definition of specific interventions and analysis of potential benefits
- Difficulties, mostly for smaller entities, to identify proper number of intervention to attract dedicated financial resources
- Complexities in bringing together different municipalities
- Lack of specialized knowledge for the structuring and selection of the proper energy performance contracts (with or without Public-Private-Partnership)
- Lack of monitoring instruments and skills

In this context CERtuS has investigated all the different options of technical configuration, of financial structure, of contractual arrangement of nZEB projects through 12 pilot cases in four different regulatory and climatic frameworks as reported synthetically in the following image. Buildings were selected by the Municipalities in cooperation with designers with the aim of defining nZEB solutions of interventions.



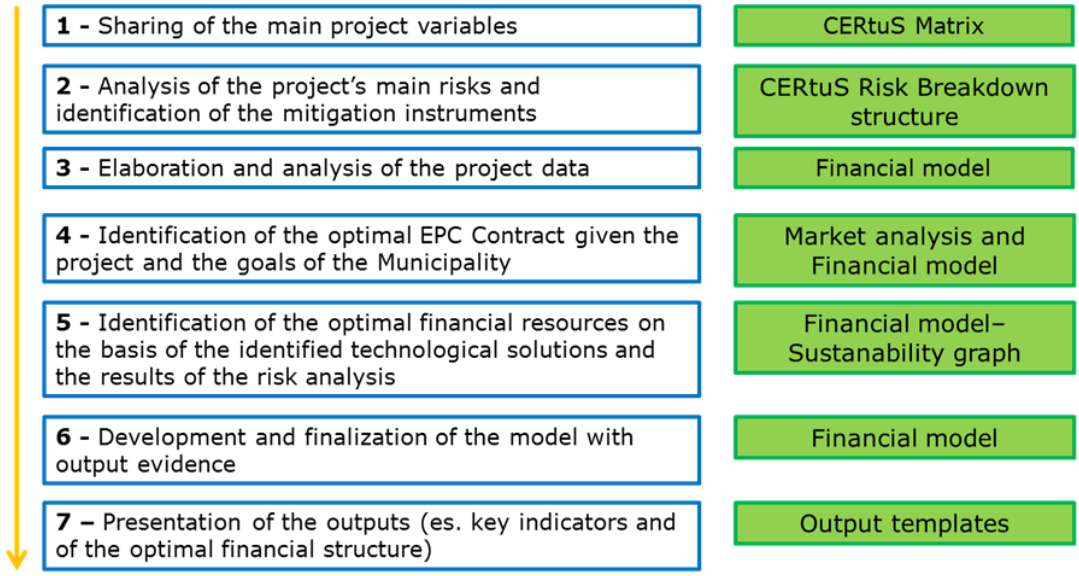
The sample under analysis, even though it represents projects with different features and specificities due to different geographic location, starting conditions and identified technologic solutions, is limited compared to the multiple possibilities of the four Countries. Thus, in order to make an economic, financial and risk analysis of the projects, a qualitative and quantitative evaluation process has been developed. The identified methodology, through the identified dialogue tools, starts a process of discussion between design member teams bearing complementary skills and belonging to different technical, administrative, economic, risk and contractual backgrounds.

The project has in fact brought together innovation elements concerning the definition of development options and project structuring but also good practices and market standards for the methodology of analysis and of risk and investment assessment.

The above-mentioned methodology presents the following characteristics:

- It checks at the same time the sustainability and the nZEB profile of an energy efficiency project.

- It simulates the market practice and it can be understood by the market operators.
- It's based on analysis/communication standards commonly used in the market and, if used in a widespread way, it may facilitate the comparison between the interested parts such as municipalities, construction and management companies (including ESCos) and financial institutions.
- Is based on a multidisciplinary analysis process and a set of data sharing and modelling tools capable of sharing in an efficient way the project variables and to evaluate the projects from every single point of view.
- Finally, the CERtuS economic evaluation methodology was based on the following seven working stages and tools:

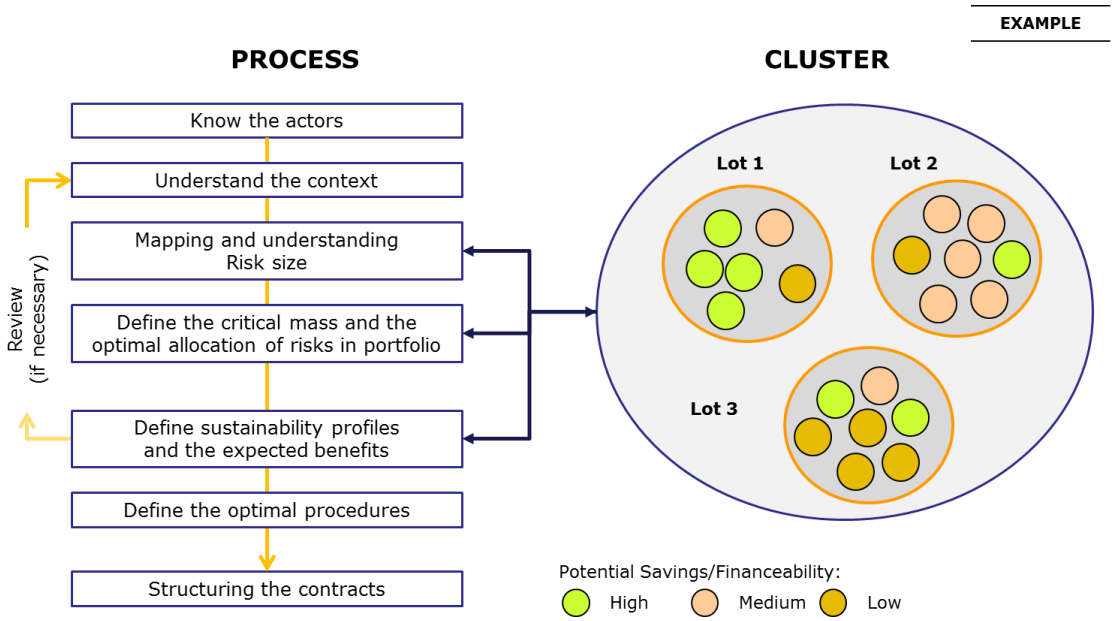


The sharing of information since the beginning, based on a common methodology, also responds to the need of finding the most efficient solutions for the specific case examined. On the basis of the technological solution pointed out by the designers, a risk, economic and financial analysis will be carried out. In particular, the following work consists of finding the optimal financial structure, the related financial instruments and the management contract (Energy Performance Contract).

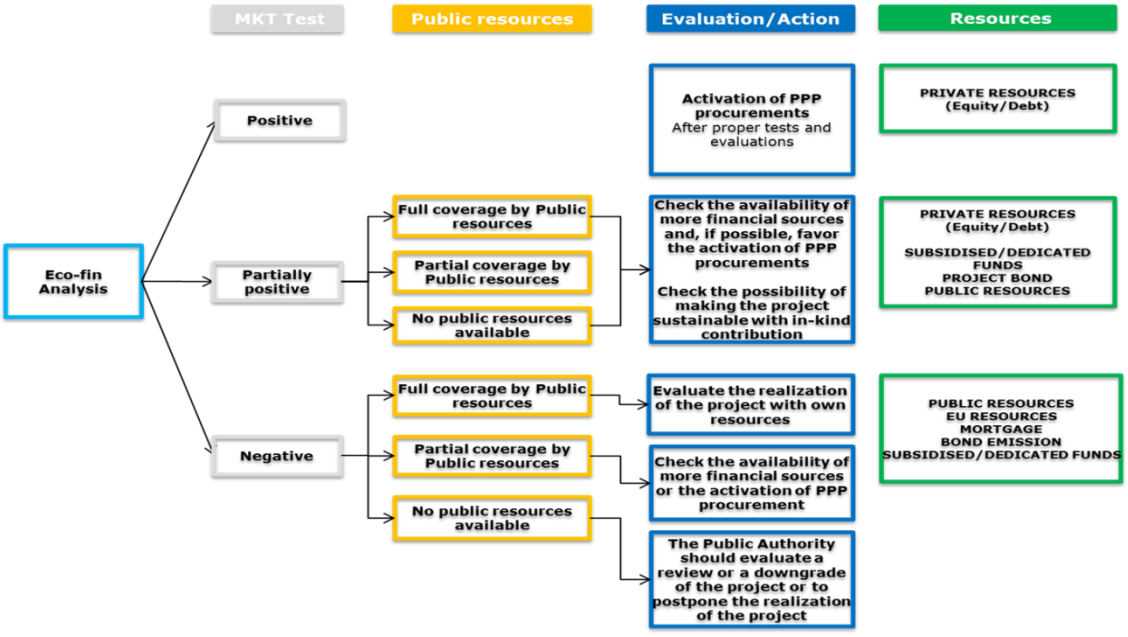
The identified methodology led to the development of conceptual matrixes supporting some main tools for dialogue and exchange of information with the other Project partners, as CERtuS Matrix (to collect information) and Risk Breakdown structure (to analyze the risk and mitigation instruments). These matrixes were designed on the basis of the previous experiences of the Partners in energy efficiency projects. One of the strategic matrix defined is the "Sustainability vs nZEB Energy Efficiency" matrix (see the following Figure).

Every renovation project is analyzed in order to understand if it is (i) market sustainable, (ii) partially market sustainable or (iii) not sustainable at market condition within the hypothesis that the renovation option is realized and manage by an ESCO.

Even if the recommendations stem from a sample of 12 pilot projects, they are also based on the hypothesis, consistent with the sector's good practices, that the project would have an inclusive and portfolio development.

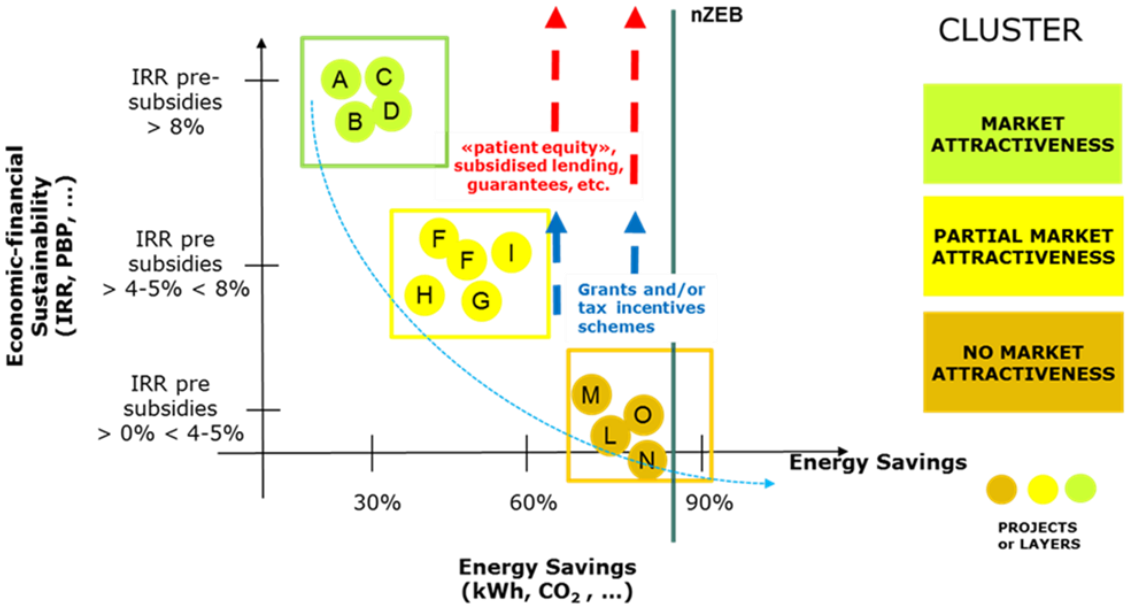


Moreover, particular attention has been placed on marketing testing and on the identification procedure of possible financial solutions that useful to enable the realization of non-sustainable projects, activating where possible leverages based on Public-Private-Partnerships and on match funding. The following graph illustrates the logic steps that have been followed.



Given the heterogeneity, the complexity and the payback period of nZEB projects, CERtuS has highlighted the importance of fine-tuning and optimizing the use of different financial resources in order to maximize the intervention spectrum.

Making use of match funding, and thus reducing the amount of grant resource, given their scarcity, is an important leverage factor that should be implemented in order to increment the number of nZEB projects. It is thus fundamental to increment the widespread of financial instruments that are designed for nZEB interventions.



The graph aims to compare the three main factors that characterize nZEB projects:

- the energy efficiency achieved in the nZEB projects: "Energy Savings "
- the sustainability of the project in terms of profitability for the ESCo that takes charge of the project: "IRR for the ESCo"
- the placement of the project in market: 3 Cluster were identified (Cluster 1: Market attractiveness; Cluster 2: Partial market attractiveness; Cluster 3: No market attractiveness) and, consequently
- assumptions or expectations of investors who can effectively use their resources for the realization of the specific project

The 12 CERtuS pilots are very different in terms of size of the buildings, starting situation, intended use and technology choices to achieve nZEB goals. The analysis has interested a restricted but diversified sample and was possible to produce, the following considerations:

- In a sample of twelve projects nZEB, few were directly sustainable at market conditions adopting an Energy Performance Contract.
- Based on nZEB projects, ESCos are often not able to repay the investment except in periods longer than 20 years.

- According to the analysis developed, it was possible to ascertain that it's very difficult to reach the nZEB threshold by developing projects in public-private partnership at market conditions involving an ESCo in the southern European countries. As a matter of fact, as verified in some previous experiences of the project Partners, the typical energy savings threshold obtainable at market conditions is around 30%-40%. For this reason, energy savings are therefore achievable only by realizing more investments that are not always feasible at market conditions and that usually need to be financed with specific ad hoc financial instruments or public grants.
- Given the analysed sample, in most of the cases it emerged that, in order to make the projects attractive for the market, there was the need of structuring a very strong financial support with important percentages of public grant and subsidized funds while reducing the percentage of equity invested (this never lower than 8%/10%).
- Financial unsustainability, subject to market conditions, is mainly due to several factors:
  - in the four countries, while using the same technologies, buildings' initial characteristic (e.g. construction year, size, use, climatic conditions, …) have led to different results;
  - technological solutions, currently available in the market, are quite expensive if compared to savings (e.g. thermal insulation coating or windows replacing, etc.) with a negative impact on project's economic and financial sustainability;
  - the cost of interventions with medium and long term payback time, for example interventions concerning the improvement of the building skin, passive or hybrid systems;
  - the additional cost of special constructions or systems, compared with conventional, which are required for listed buildings;
  - energy efficiency interventions may improve the ability of Municipalities to identify appropriate maintenance frequency compared with the initial situation with an increase of maintenance annual costs entirely sustained by the ESCO. This aspect, although it initially increases public expenditure, is fundamental for the proper maintenance of the new plants.

CERtuS evaluation highlights that financial sustainable projects must have the following characteristics:

- A well-defined baseline of energy consumption and maintenance costs must be clearly-defined
- A proper examination not only of energy but also of economic savings. It is essential to consider also pre and post maintenance costs
- A careful evaluation of energy carrier acquisition costs to identify if they are in line with current market conditions

- Identification of projects that have short payback periods, coherent with the contract's duration and thus sustainable projects
- Aggregation of different buildings and critical mass in particular when single interventions are of small scale
- Increase the awareness of Energy Performance Contracts mechanisms
- Provision of a careful monitoring scheme in order to assess the performances in terms of energy savings
- If possible, they must lead to a more efficient management of public buildings in a context of grater utilization of the same building (for instance in different hours) also for other activities. This would imply more resources given by the public administration to the ESCo, promoting thus its appeal on the market
- Enlarge the services expected from the ESCo, thus in addition to the management and maintenance of the installations, the opportunity of facility management could be delegated
- Activation of technical assistance lines to structure projects that are able to fulfil the needs of stakeholders, public and private ones
- Identification of development methods for project realization that favour Public-Private-Partnerships.

3.11 CERtuS SUITABLE SERVICE MODELS FOR THE MUNICIPALITIES

CERtuS consortium has also identified the types of EPC contracts more suitable for the realization of energy saving actions carried out in each of the four municipalities. In particular, CERtuS indicated the appropriate tools to allow individual municipalities to choose the type of contract/s that will be most suitable to meet their needs.

Each municipality have performed energy audits to their buildings according to the applicable law in its country in order to estimate the energy saving and identify the financial viability for the renovation projects through the appropriate EPC contract. In order to identify the type of EPC contract most suitable to apply to each project, a methodology has been developed.

The CERtuS answer on how Municipalities can finance nZEB and other energy related intervention to their building stock.

The CERtuS decision making tool to choose the most suitable type of contract, among EPC based on the needs of the Municipalities.

Based on results developed within the action the CERtuS methodology analysed each type of contract previously identified and categorized through a "Risk Array", which subjects, ESCOs and Municipalities, the individual risk is attributable.

- The “Risk Array” maybe considered as a decision making tool to choose the most suitable type of contract, among EPC based on the needs of the Municipality. This because each contract has a number of risks for each of the contracting parties, so at first it is necessary identify the risks that may normally be present in a complex contract as the EPC where there are technical, operational, economic and financial aspects.
- This tool is developed within the project by the collaboration of financial partners and the Association of ESCos. The risks may arise during the different phases of the energy efficiency project managed through an EPC contract; then, for each phase, the following table describes all possible risks and their drivers.
- In order to indicate how each risk is distributed between the ESCO[2] and the Municipality in each EPC contract[3], it is assumed to be assigned scores related to the risk entity, as: (i) 2,00 = Maximum risk; (ii) 1,5 = Prevailing risk; (iii) 1,00 Risk-sharing between the parties; (iv) 0,5 = Minimal risk; (v) 0,0 = No risk.
- So, considering the types of risk and assigning the above scores, it is possible to obtain the following table that shows, for each EPC contract, how each driver risk is, exclusively or overwhelmingly, in charge of the ESCo or Municipality.

[2] in the definition of ESCO is intrinsically provided the need to take risks and the magnitude of these risks compared with the earnings identifies the attractiveness of a given initiative. The right balance of risk diversification and cost savings between the parties determines the success of an initiative to improve energy efficiency based on an EPC contract.

[3] Each contract provides that one or both parties assume risk among those listed in the Array. This means that at first it is necessary identify the risks that may normally be present in a complex contract as the EPC where there are technical, operational, economic and financial aspects.

PHASES	TYPE OF RISK	DRIVER OF RISK
ENERGY AUDIT	Risk of audit	Wrong or not correct audit
		False detection/estimation of maintenance and repair costs
		False detection/estimation of potential regulatory changes
PLANNING	Risk of planning	Incorrect or unsuitable design
		Increase in design costs
AUTHORIZATION	Regulatory Risks	Lack of regulations / lack of information about regulations
		Delays / difficulties obtaining authorizations and permits
	Political Risks	Sociopolitical instability
FINDING FUNDING	Financial Risks	Obtaining funding
		Fluctuation in interest rates
START WORK AND CONSTRUCTION	Environmental risks and conditions of the site	Environmental impact of the intervention (eg. Noise)
		Static and Geological conditions of the site
		Discovery finds historical/archaeological
	Construction Risks	Non-conformity to the project
		Delayed delivery or impossibility of completion of the works
		Increase in construction costs
		Possible default of subcontractors
MANAGEMENT	Market Risk	Increased operating costs (maintenance, etc.)
		Change of use, occupation, mode of use of the building
		Increases in energy costs
		Regulatory changes
		Change of the incentive system
		Change in taxes (tax and VAT)
		Increase in insurance costs
		Changes in the dynamics of the indices of the royalties revisional
		Change in the rate of inflation
	Counterparty Risk	Local Authorities Rating
		ESCo Rating
		Risk of default by ESCo
		Financial and technical reliability of suppliers of heat and electricity
		Provider of incentives
	Technological Risk	Lack of performance of technologies/facility
		plant shutdown/breaking plant
		Increase in maintenance
		Damages for accidents or erroneous management
		Risk resulting from innovative technologies
	External Risks	Occurrence of acts of God
		Climate risk

RISK ARRAY

PHASES	TYPE OF RISK	DRIVER OF RISK	FIRST IN		FIRST OUT		GUARANTEED SAVINGS		SHARED SAVINGS		PAY FROM SAVINGS		FOUR STEPS		BOOT		CHAUFFAGE	
			ESCo	EELL	ESCo	EELL	ESCo	EELL	ESCo	EELL	ESCo	EELL	ESCo	EELL	ESCo	EELL	ESCo	EELL
ENERGY AUDIT	Risk of audit	Wrong or not correct audit	2		2		2		2		2			2	2		2	
		False detection/estimation of maintenance and repair costs	2		2		2		2		2		2		2		2	
		False detection/estimation of potential regulatory changes	2		2		2		2		2			2	2		2	
		Evaluation %	**100%**	**0%**	**100%**	**0%**	**100%**	**0%**	**100%**	**0%**	**100%**	**0%**	**33%**	**67%**	**100%**	**0%**	**100%**	**0%**
PLANNING	Risk of planning	Incorrect or unsuitable design	2		2		2		2		2			2	2		2	
		Increase in design costs	2		2		2		2		2			2	2		2	
		Evaluation %	**100%**	**0%**	**100%**	**0%**	**100%**	**0%**	**100%**	**0%**	**100%**	**0%**	**0%**	**100%**	**100%**	**0%**	**100%**	**0%**
REGULATORY	Regulatory Risks	Lack of regulations / lack of information about regulations	1,5	0,5	1,5	0,5	1,5	0,5	1,5	0,5	1,5	0,5			2		1	1
		Delays / difficulties obtaining authorizations and permits	1,5	0,5	1,5	0,5		2	1,5	0,5		2			2		2	
		Sociopolitical instability	2		2		2		2		2				2		2	
		Evaluation %	**83%**	**17%**	**83%**	**17%**	**58%**	**42%**	**83%**	**17%**	**58%**	**42%**	**0%**	**0%**	**100%**	**0%**	**83%**	**17%**
PROCUREMENT OF FINANCE	Financial Risks	Obtaining funding	2		2			2	2			2			2		2	
		Fluctuation in interest rates	2		2			2	2			2			2		2	
		Evaluation %	**100%**	**0%**	**100%**	**0%**	**0%**	**100%**	**100%**	**0%**	**0%**	**100%**	**0%**	**0%**	**100%**	**0%**	**100%**	**0%**
STURT UP AND CONSTRUCTION	Environmental Risks and conditions of the site	Environmental impact of the intervention (eg. Noise)		2		2		2		2		2		2		2		2
		Static and Geological conditions of the site	2		2		2		2		2			2	2		2	
		Discovery finds historical/archaeological	1,5	0,5	1,5	0,5	1,5	0,5	1,5	0,5	1,5	0,5		2	2		2	
		Evaluation %	**58%**	**42%**	**58%**	**42%**	**58%**	**42%**	**58%**	**42%**	**58%**	**42%**	**0%**	**100%**	**67%**	**33%**	**67%**	**33%**
	Construction Risks	Non conformity to the project	2		2		2		2		2			2	2		2	
		Delayed delivery or impossibility of completion of the works	2		2		2		2		2			2	2		2	
		Increase in construction costs	2		2		2		2		2			2	2		2	
		Possible default of subcontractors	2		2		2		2		2		2		2		2	
		Evaluation %	**100%**	**0%**	**100%**	**0%**	**100%**	**0%**	**100%**	**0%**	**100%**	**0%**	**25%**	**75%**	**100%**	**0%**	**100%**	**0%**
MANAGEMENT	Market Risk	Increased operating costs (maintenance, etc.)	2		2		2		2		2		2		2		2	
		Change of use, occupation, mode of use of the building	2		2			2	2	1		2					2	
		Increases in energy costs	2		2			2		2		2		2	2		2	
		Regulatory changes	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
		Change of the incentive system	1,5	0,5	2		2		1,5	0,5	2				2		2	
		Change in taxes (tax and VAT)		2		2		2		2		2		2		2		2
		Increase in insurance costs	2		2		2		2		2			2	2		2	
		Changes in the dynamics of the indices of the royalties revisional	1	1													1	1
		Change in the rate of inflation	0,5	1,5	2		2				2			2	2		1,5	0,5
		Evaluation %	**67%**	**33%**	**81%**	**19%**	**56%**	**44%**	**57%**	**43%**	**56%**	**44%**	**25%**	**75%**	**79%**	**21%**	**75%**	**25%**
	Counterparty Risk	EELL Rating	2		2			2	2			2	2		2		2	
		ESCo Rating		2		2		2	1	1		2		2		2		2
		Risk of default by ESCo		2		2		2	1	1		2	2			2		2
		Financial and technical reliability of suppliers of heat and electricity	2		2		0,5	1,5	2		0,5	1,5		2	2		2	
		Provider of incentives	1,5	1	2		1	1	2		2	2		2	2		2	
		Evaluation %	**52%**	**48%**	**60%**	**40%**	**15%**	**85%**	**80%**	**20%**	**21%**	**79%**	**40%**	**60%**	**60%**	**40%**	**60%**	**40%**
	Technological Risk	Lack of performance of technologies/facility	2		2		2		2		2			2	2		2	
		plant shutdown/breaking plant	0,5	1,5		2		2	0,5	1,5		2		2	2		2	
		Increase in maintenance	2		2		2		2		2		2		2		2	
		Damages for accidents or erroneous management	2		2		2		2		2		2		2		2	
		Risk resulting from innovative technologies	2		2		2		2		2		2		2		2	
		Evaluation %	**85%**	**15%**	**80%**	**20%**	**80%**	**20%**	**85%**	**15%**	**80%**	**20%**	**60%**	**40%**	**100%**	**0%**	**100%**	**0%**
	External Risks	Occurrence of acts of God		2		2		2		2		2		2		2		2
		Climate risk	2		2		0,5	1,5	1	1	0,5	1,5		2	2		2	
		Damage to third parties		2		2		2		2		2		2	2			2
		Evaluation %	**33%**	**67%**	**33%**	**67%**	**8%**	**92%**	**17%**	**83%**	**8%**	**92%**	**0%**	**100%**	**67%**	**33%**	**33%**	**67%**
TOTAL RISKS			**75%**	**25%**	**78%**	**22%**	**58%**	**42%**	**75%**	**25%**	**58%**	**42%**	**27%**	**73%**	**85%**	**15%**	**80%**	**20%**

The Energy Performance Contracting model is highly replicable in the EU and internationally recognized as a guaranteed, cost effective and scalable procurement method for reducing the operating costs and environmental impacts of buildings.

In order to promote EPC at the European Southern members states level it is necessary to address key barriers such as lack of awareness and/or lack of knowledge, lack of policies and support mechanisms, lack of common definitions and harmonized processes.

In practice, under a performance contract, an Energy Services Company (ESCO) provides a comprehensive building retrofit, which can include i.e. the replacement of boilers, insulation, cooling systems, lighting and temperature automation controls, as well as the integration of energy data management software and on site renewable energy systems.

The ESCO takes complete “turn-key” responsibility for the project, meaning it covers all aspects of the project from start to finish: preliminary energy audits, detailed design and engineering, business case, analysis, installation, commissioning, and performance measurement and verification.

The ESCO acts as an overall project manager and will divide the retrofit works into specialized areas, which will be contracted to local specialized partners, the ESCO keeping the overall responsibility for the work and the guaranteed energy savings. For that reason, EPC projects are using local Small and Medium Enterprises (SMEs) and in turn this contributes to the development of the local job market.

Each contract must be able to adapt to current needs of both parties; therefore, the EPC contract must comply with this rule.

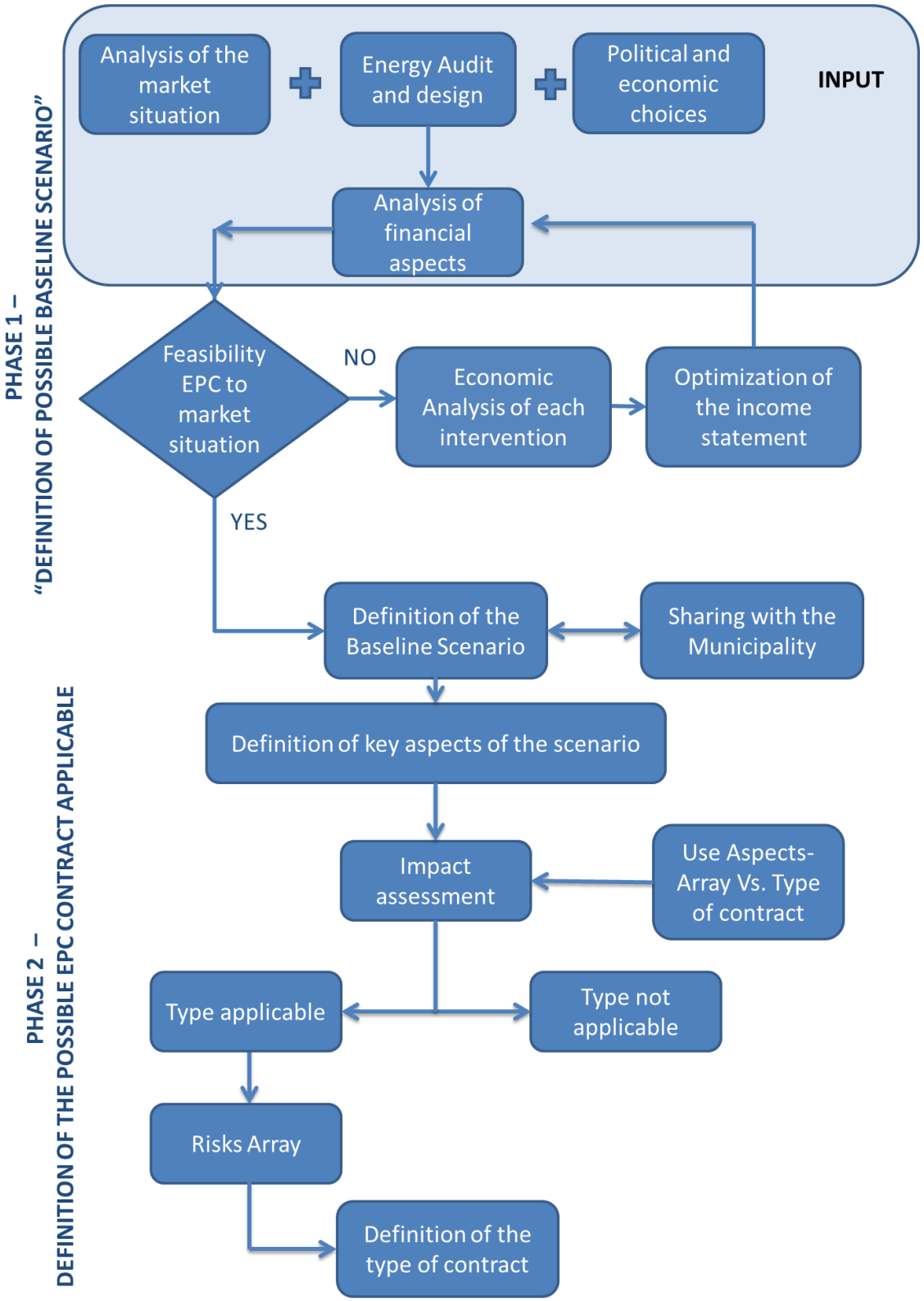
The CERtuS methodology to obtain suitable service models.

CERtuS suggests, on based of the political and economic framework, the type of EPC contract applicable to the specific renovation project. In addition to the "Matrix of Risks", which allow to the Municipality to assess each type of contract on based of the allocation of the various risks between the two Parties, a methodology and a "Baseline Scenario" defined within the action. Starting from the Baseline Scenario we have identify the type of EPC contract applicable.

The methodology, as illustrated below with a diagram of flows, has been created for the evaluation of the twelve CERtuS pilot projects but it can be easily applied in a similar manner by each municipality who intends to proceed to interventions of transformation of buildings in nZEB through an EPC contract.

The application of the methodology for all twelve projects wants to be an example of the way of application thereof and of the results which may arise.

During the work, varied situations are being encountered that start right from the choice of the buildings to transform into nZEB.


PHASE 1 – "DEFINITION OF POSSIBLE BASELINE SCENARIO"
Analysis of the market situation
Energy Audit and design
Political and economic choices
INPUT
Analysis of financial aspects
Feasibility EPC to market situation
NO
Economic Analysis of each intervention
Optimization of the income statement
YES
Definition of the Baseline Scenario
Sharing with the Municipality
PHASE 2 – DEFINITION OF THE POSSIBLE EPC CONTRACT APPLICABLE
Definition of key aspects of the scenario
Impact assessment
Use Aspects-Array Vs. Type of contract
Type applicable
Type not applicable
Risks Array
Definition of the type of contract

In all twelve CERtus pilot cases, the municipalities did not have the resources to fully fund the planned measures from which it was necessary to resort to involvement of private partners through the instrument of the Energy Performance Contract and the Third-party financing. Just this requirement makes it more pressing the assessment of the "technical convenience / economic" of the realization of a nZEB transformation. The assessment as to the existence of minimum conditions to ensure that projects are feasible at standard market conditions has shown us that only two of the twelve projects analyzed are in this condition.

For the remaining ten are necessary adjustments that address the reduction of the investments or the use of own capital of the municipality or the use of subsidized funds.

Comparing this figure with the park buildings analyzed, it would seem that the upstream choice should fall on energy-intensive buildings, but medium-sized precisely to find the right balance between investment value and cost savings.

The following table shows that we have assumed a reduction of investments with a slight reduction of energy savings for only 50% of the projects; in 5 cases out of twelve it was assumed the use of own capital of the municipality, in 3 cases out of twelve the use of concessional funds and in 2 cases out of twelve both.

Regarding the contract type to be applied, it follows from the table below that the most usable contract is certainly the Shared Saving, even if in three situations is combined with the Chauffage, especially in Italy where energy supply by the ESCo is quite usual, or with Guaranteed Saving, where the renovation involves a change of use of the building and therefore is necessary to use a substantial portion of non-repayable capital of the Municipality.

Location / Country	Building	Type of EPC contract
Messina, ITALY	▪ Zanca Palace ▪ Palace of Culture “Antonello Da Messina” ▪ Satellite Palace	FIRST IN + SHARED SAVING + CHAUFFAGE
Alimos, Greece	▪ Municipal Environmental Offices ▪ City Hall ▪ Municipal Library	SHARED SAVING
Coimbra, Portugal	▪ Town Hall ▪ Municipal house of Culture ▪ Elementary school of Solumn	SHARED SAVING
Errenteria, Spain	▪ Town Hall ▪ Capitan Etxea ▪ Lekuona	SHARED SAVING GARANTED SAVINGS + SHARED SAVING

Summary of types of EPC contract provided for 12 CERtuS pilots

It should also be pointed out that the results presented should be considered only as examples to illustrate the application of a methodology of work, with tools created ad hoc; once the municipality will want to put into practice the projects presented, these will need to be checked in updating costs, verifying the market assumptions relating to standard conditions, rechecking the Baseline Scenario, and finally making a new economic analysis after having explored the possible concessional funds existing.

4 RESULTS AND FINDINGS AND IMPACTS ACHIEVED

4.1 CERTUS RESULTS AND FINDINGS

Reaffirming that the CERtuS project was designed in 2013 and none of the involved Southern countries have had at that time a detailed definition on the nZEB, the project consortium considered as CERtuS nZEB definition, the one having the following targets to reach:

- ✓ 75% - 80% improvement of the overall energy efficiency or to the levels indicated by the national regulations for nZEB if better
- ✓ Use of RES in the interval of 70% - 90% of the current heat, cool and electricity demand

According to this range of values proposed and reached in the majority of the 12 renovation options, CERtuS can truly be considered a success story when looking back at the results and findings of its overall activities. These main CERtuS results include:

- ❖ The CERtuS project have five out of twelve buildings listed for which strict and particular regulation apply. Although the difficulties faced were enormous, for these buildings up to a 70% primary energy reduction has been achieved, which is very close to the planned target of the project (75%-80% of the current demand). Greater % were technically reachable, but economically were not viable.

- ❖ Eight out of twelve CERtuS pilots have met the target of RES use between 50 and 90%. However, the reached % of RES used in the remain buildings is very close to the target.

- ❖ CERtuS pilots achieved a sustainable economic implementation of the renovation schemes that implies an average pay-back period of 15 years for the 12 model cases.

- ❖ The necessary cumulative investment to implement the nZEB renovation options is 36,917,428 €. CERtuS has optimised investment and showed that the set targets can be achieved with an average cost of 117,4 €/m^2. This is the cost used to calculate the actual achievement instead of the planned 1400 €/m^2 (which involved deep renovation on the building envelope, an option that was applied in very few CERtuS buildings).
  This investment according to the CERtuS project outputs can be ensured by a combination of funding sources including ESCOs, soft loans, senior debts and VAT facility.

- ❖ CERtuS contributed to a better and deeper knowledge on the current barriers and difficulties of the involved countries in proposing effective schemes for nZEB renovations: The analysis of the current obstacles and gaps faced by the projects in the 4 countries revealed different situations, but simultaneously they

have in common the financing difficulties whilst the technical issues are of secondary relevance.

The feedback received from Round Tables, person to person meetings and questionnaires in the four countries are:

- The Municipality of Messina (Italy) has surprised as the outcomes depict the disinterest by political and administrative components in the issue on energy efficiency and nZEB renovation design. On the basis of this result there are institutional misunderstandings, disappointments of private sector in supporting the public action and inability of public administration to manage the process of Energy Efficiency and nZEB renovation. Other important obstacles identified are the current lack of available capital in the public sector, the small size of ESCOs in the local market and their short experience in executing projects (due to their recent foundation). In addition to, the Energy Performance Contracting with public sector clients are considered a high risk business. The figures emerge from the Municipality of Messina which belongs to the region of Sicily, under a special statute and can be considered fairly representative of Southern Italy municipalities.
- The Municipality of Alimos (Greece), faced up the risks, obstacles and constraints in two workshops addressed to the central government and technology suppliers respectively. The most significant conclusions drawn are that the major obstacles for the nZEB renovation in the municipality buildings concern the current harsh economic conditions and the bureaucratic obstacles. Also, major obstacle is considered the reluctance of existing ESCOs to face the legal, administrative and bureaucratic uncertainties and procedures.
- The Portuguese and Spanish stakeholders interviewed, have a common denominator. It has been identified the financial barriers and the willingness and political decision as the most important obstacle for the nZEB renovation projects of public buildings. The technical barriers and the legal framework are therefore not considered strong barriers. Analyzing deeply the financial aspects has emerged that the stakeholders have identified the overall investment as the main barrier, followed by the lack of public budget for nZEB renovation and the difficult access to financial schemes.

❖ The project added also considerable experience on the obstacles, risks and difficulties for the renovation schemes of each involved municipality. Four different reports highlighted the technical difficulties, the economic barriers and the legislative obstacles encountered during the course of the project. The main achieved results for each Municipality concern:

<u>Municipality of Messina, Italy</u>

- Technical difficulties: Two of the three examined buildings do not face particular technical difficulties that impeded their deep renovation. However, there is a difficulty with regard to the integration of renewable

energy systems when the building is located in a densely built urban area and in the case of Palazzo Zanca, because it is a historic building bound by the Cultural Heritage.

- Other difficulties were observed in the internal distribution of space for offices because the existing structures are not flexible, and the possible interventions are limited by the presence of functional destinations very different from each other (offices, museum, theater etc.), and therefore it results very difficult to implement common interventions.
- Economic barriers: One of the main issues of renovation projects of Public Administration in the Italian context is public financing, due to the economic crisis. For this reason, it would be essential to declare that the renovation project would be both important from the point of view of sustainability and from the economical point of view since it would generate an energy and cost saving. Additional risks that all investors face in Italy are the frequent changes in legislation and in taxation system which have an enormous effect on the economic evaluation of the energy projects.
- Legislative obstacles: Another main obstacle regarding deep energy renovation of public buildings during the first phase of the project was the lack of legislation regarding the nZEB definition. However, the related legislation and definition and of the nZEB in Italy came in force by the middle of 2015, when the renovation options of the CERtuS pilots had already reached the completion. One of the main issues related to the early design phases is indeed the gathering of all the necessary data about the state of art (drawings, bills, system maintenance documents, etc. However, all the necessary information should be gathered in order to develop the project: the support of all the actors (designers, municipalities, public energy managers and societies…) would be surely favored by an appropriate national legislation which would empower the involved subjects.

<u>Municipality of Alimos, Greece</u>

- Technical difficulties: In general, the three buildings which are examined do not face particular technical difficulties that impede their deep renovation. However, there is a difficulty regarding the integration of renewable energy systems when the building is in a densely built area. This is due to the lack of space availability, the reduced solar potential due to shadowing and the reduced wind potential. In Greece the legislation defining the levels of nZEB and the contribution of RES in the energy performance of nZEB is under development. So, it is important the “nearby areas”, as indicated by EPBD, to be defined as flexibly as possible in order to facilitate the integration of RES and make nZEB levels achievable.
- Economic barriers: The main problem in order to undertake energy performance improvements in public buildings is the lack of funds that municipalities face during the last years affects the whole process of the energy efficiency interventions. This fact can block the completion of the

renovation and will result to lower savings than the expected ones. For this reason, it is very important the economic support in order the interventions to be feasible. Also, subsidies by government or other sources for more innovative products and solutions will help their penetration in the market and at the same time will eliminate the financial risk for the investors. Additional risks that all investors face in Greece are the frequent changes in legislation and in taxation system which have an enormous effect on the economic evaluation of the energy projects.

- Legislative obstacles: Another main obstacle regarding deep energy renovation of public buildings is the lack of legislation regarding the nearly zero energy buildings (nZEB). It is expected however, that the legislation will be in force by the end of 2015.

  Finally, other difficulties which have to be overcome during the energy efficiency renovation of public buildings are the difficulties in gathering all the data (drawings, bills, system maintenance documents, etc.) which are required for the study and the whole bureaucratic procedure in order for the project to be approved by the authorities.

Municipality of Coimbra, Portugal

- Technical difficulties: The most important general technical risk is the quality of the products. In a public procurement process the brand and model of the technology cannot be previously chosen and therefore there are always uncertainty regarding the quality of some products proposed by the installers (lifetime, quality of light in the lighting products, etc.). The main technical difficulties are the use of electricity in other buildings managed by other entities without any metering to ensure the disaggregation of consumption between the buildings, in the School and the Library. Other important technical barrier is the incompatibility between use and renovation works in the Library and Town Hall. There is also the technical risk in the quality of products due to the need of public procurement processes.
- Economic barriers: The main economic barrier is the high overall investment, which is aggravated by the lack of public budget and the low availability of financial schemes. The main economic risk is uncertainty on the assessment of the total investment needed to the implementation due the regular variations of costs and uncertainty about the percentage of price reduction achieved in the public procurement process. In the case of the installation of solar tiles in the Town Hall the risk is higher due to the low availability of solutions in the national market.
- Legislative obstacles: The main legislative obstacle is the protection level of the Town Hall, since it is part of the property “University of Coimbra - Alta and Sofia” inscribed on the World Heritage List of UNESCO. Therefore, several strong restrictions are applied in the renovation of such building with high impact on the options of renovation in the envelope and on installation of renewable generation.

Municipality of Errenteria, Spain

- Technical difficulties: The main technical difficulties encountered in the renovation scheme design are related to the physical characteristics and the use patterns of the buildings. In the case of Kapitain Etxea building, the small dimensions of the building determine the selection of some technologies; in the case of the City Hall, the use of the building by Municipal employees and the public limit the selection of intrusive measures which would require the closure of the building; while in the case of Lekuona building the ongoing renovation already addresses some of the objectives pursued in this project.
- Economic barriers: The main economic barrier of the implementation of the renovation schemes is related to the lack of public budget and low availability of financial mechanisms, while main legislative obstacles are associated on one hand to the restrictions applied to the historic town, listed due to its historical and aesthetical values and on the other hand to the current unclear legal situation of PV technology as, since 2013, the funding of PV panels was abolished retroactively.
- Legislative obstacles: The main legislative obstacle is related to the use of PV technology to produce electricity. Currently there is a draft project that limits the capacity of buildings to install PV system for self-consumption of electrical energy. For this reason, this sector is partially stationary due to the uncertainty of the situation, without a mandatory rule and with a provisional project. However, this draft has not been approved since it was issued in 2013 and it is questioned by important sectors of the politics, industry and society. An eventual change in the Government could entail its modification or its revocation.

The achieved results are closely connected with the design choices that have been made ex ante by each Municipality in the identification of the related renovation solutions.

- The Project has also identified and provided proposals for regulation improvements and has outlined the following:
  - Portuguese, Spanish and Italian results are aligned to draw attention to the current gap between disciplines that regulate energy efficiency interventions and integration of RES also on historic buildings, bound by the laws of protection. Contrarily, the regulatory frame investigated by the Greek partners is applied to new – contemporary buildings, as the local treated buildings belong to the contemporary period.
  - Results highlighted by the Portuguese overview show that there are no relevant environmental obstacles or regulatory gaps to the installation of energy efficiency technologies and renewable energy in buildings and its use in urban areas. The major obstacles to the use of renewable energy technologies and to the deep renovation of the building envelope are the protection rules in listed buildings. Other restriction to the large scale

installation of renewable energy technologies regards the tariff, since the energy injected into the grid is penalized with a very low tariff.

- The study for energy efficiency regulations and RES integration in Spanish urban areas provides an overview on two sets of regulations -that which govern places of historic significance and those which deal with energy efficiency. The report concludes with important, detailed and specific recommendations coming from the present study on regulations. It also presents in detail a specific topic on regional laws and regulations covering historic building protection in the Basque Country where the study was conducted. At national level it describes the gap between the environmental regulations and those enforced to protect historic structures.
- The overview of the legislation pertinent to energy efficiency and integration of RES in buildings of Alimos municipality and discusses the problems and gaps identified along the renovation design of the three local case studies. It highlights important results and difficulties, as: (i) the main problem regarding the energy renovation of public buildings is that a renovation / construction contract is awarded based on the lowest price and not on the amount of energy conservation (ii) there are many difficulties regarding the implementation of the renovation plans by means of an ESCo model due to bureaucratic procedures and partial implementation of the relevant legislation.
- Results presented by the Italian overview show obstacles and gaps and define some generic compensatory measures, as in Italy there are obstacles to the application of nZEB Directive depending by a set of rules which focus on other aspects than those of energy management of buildings. The results mainly focus in the current urgent need which is a 'one single Coordination' composed of members of the relevant ministries and a legislative text on energy efficiency in buildings that also takes into account the historical buildings. More possible actions are mentioned as Declaratory, Training and other actions to increase the public awareness.

Furthermore, an overview of the relevant regulation/legislative framework of each participant country and notes about the authorization procedures for construction and installation of plants powered by renewable energy sources systems are included in the results.

- The CERtuS team has also contributed to the definition of the economic, legal and policy conditions prevailing in each participating Municipality, relevant to renovation project financing. The rationale of this aspect was to frame the development of the energy service models and of the optimal financing schemes to be adapted to the emerging needs of the Municipalities as well as to the size and to the risks of this kind of energy renovations projects. The partners investigated the state of the art of energy renovation experiences of partner municipalities in order to: (i) detect existing barriers to be overcome; (ii)

identify the opportunities to be seized by pointing out specific local conditions; and (iii) pave the way for the main CERtuS actions.

The main outputs coming out from this analysis are hereinafter summarized:

- Three out of four municipalities need to overcome some barriers for implementing energy renovation projects for their existing building stock (from cultural resistance to the lack of a clear regulatory framework);
- Three out of four municipalities have already experienced energy renovation especially in schools and in sports buildings;
- Almost all the four municipalities have few public financial instruments at disposal and they need to complete these public funding with private ones. As a matter of fact, in some cases, there are available specific measures to boost the ESCOs market through the Energy Savings and Efficiency Action Plan 2011-2020. In other countries, it is a priority to use private funding but still the regulatory framework is not clearly set up.
- Almost all the municipalities have in their national and regional plans measures for boosting (i) energy retrofitting in buildings; (ii) the adoption and exploitation of private funding for energy renovation project; (iii) energy certifications and in general for energy efficiency.

❖ Additionally, the CERtuS project brings another important information / tool to the Municipalities and/or to any other building titleholder in order to estimate the building's costs and expenses needed for the energy related renovation. This is CERtuS SE²T, the CERtuS Simplified Economic Evaluation Tool. SE²T has been developed under the CERtuS Project with the aspiration to become a friendly tool for municipalities that wish to implement a deep energy renovation of their buildings, in order to become nZEB.

The information of the optimum or even of the appropriate financial structure is a crucial information for the municipalities and /or the building titleholder in order to know the kind of investors one has to be addressed or the types of money sources have to be used for financing the energy retrofitting project. SE²T could be used in the early stages of building renovation projects, in order to evaluate if the project is financial sustainable.

CERtuS SE²T is a great tool for the preliminary stages of the project planning as it can adjust the size of the expectation of the building owners. Also, CERtuS SE²T' results may be used as a starting point between the building owner and the investors, as it is assumed that it gives useful and reliable information on the expected simple paypack period of the project, the economic savings and the cash flow.

Even CERtuS SE²T is a simplified tool, it requires significant information as input. Concretely, the most important information is: the intervention costs, the maintenance expenses, the expected financial performance of the investors and loans interest rates. The last two information include the valuation of political,

social, environmental, legislative technical and economic risks in accordance to national market facts. For this reason, it is important to mention that CERtuS SE²T, as a simplified tool has limitations, as for example: it doesn't take into account the exact time that the VAT is debited or /and credited, or the actual costs and expenses of a specific ESCO. Therefore, CERtuS SE²T doesn't give appropriate information on projects' cash flow and the needs for short term financing, such as the working capital.

- Finally, capacity building in Municipalities was an essential component of CERtuS output. It ensures the sustainability of the action, not only of the participating countries but of a very large target group, so as to prepare nZEB projects and plan replication. This has been done through training of the municipality technicians who are organizing the activity of nZEB renovation projects in their Municipality and of other professionals (i.e: architects, engineers, conservators of historic buildings etc.) who often and closely are collaborating with the previous ones. CERtuS team conducted almost a three-days training course in each member state. Various information and key dissemination materials have yielded in order to better support the training events and are related to:
  - ✓ 1 CERtuS flyer in English, Italian, Greek, Portuguese and Spanish language.
  - ✓ A 65-page Maxi Brochure presenting the nZEB renovation design with technical and economic data and the identified financing options for each CERtuS Municipality. The Maxi Brochure was published in English and translated in Italian, Greek, Portuguese and Spanish language.
  - ✓ A 234-page Guide illustrating technical guidelines for the development and financing of nZEB renovation design in public buildings. The Guide gives an overview of the methodology, the materials and systems for energy efficiency and renewable energy design and provides a methodology for economic appraisal and risk assessment. The overview includes financing sources and instruments currently available in the four southern countries and gives examples of the financing schemes developed in CERtuS. The Guide was published in English and translated in Italian, Greek, Portuguese and Spanish language.

The main topics of the CERtuS training courses included:

- nZEB concept and difficulties involved in deep renovations;
- How to prepare nZEB renovations projects (technical and economic requirements);
- How to prepare bankable projects;
- Energy service procurement and relevant contracts;
- Financing schemes and opportunities;
- Requirements for planning the renovation of all Municipal buildings.

The curriculum of the training courses was prepared based on the experience and knowledge acquired within the action and on feedback from the consortium, including the Municipalities. As part of the training course, a package of training materials was compiled, divided in 4 Handouts, most of them are constituted by several presentations about particular subjects.

Handout 1: "Technical guidelines for nZEB renovation, energy efficiency and use of renewable energy systems" presents the nZEB Concept, Deep Renovation and Legal Framework. Then, the renewable energy systems technologies, as well as the main energy efficiency technologies (including HVAC, lighting, control, ICT and envelope) that can be considered in nZEB renovations are presented in detail.

Handout 2: "Means and examples of technical and economic evaluation of the nZEB renovations" presents the technical evaluation with a detailed presentation of the case studies developed by CERtuS, as well as the adopted methodology for economic evaluation and economic results from the case studies. The obstacles, risks, difficulties and constrains that should be considered in the technical and economic evaluation are also presented.

Handout 3: "A guide for selecting energy services and relevant contracting" presents the Energy Performance Contract models considered during the project, as well as relevant contracting issues

Handout 4: "Examples of financially feasible renovation projects of medium to large scale" presents examples of implemented or designed projects able to ensure nZEB levels while financially feasible.

The English version of the training courses, divided in 4 handouts and 12 presentations, consisted of a total of 723 Power Point slides. All versions are available to the CERtuS Portal: http://certus-project.eu/tools/training-materials/presentations/

Then, the training materials were adapted (considering the local legislation, presenting local examples and focusing the examples in the case studies from each country) and translated in the languages of the participating municipalities (i.e. Italian, Spanish, Portuguese and Greek).

The addressed territory and defined objectives of each participant municipality were the following:

- Greece: the training courses addressed the whole country, were conducted online and were titled "Financing models for nearly zero energy building (nZEB) deep renovations of municipal buildings".
  The aim of the webinar was to promote the nZEB renovations and support municipalities in shaping renovation projects fulfilling the requirements for finance. In addition, it transferred the experience and knowledge regarding innovative financing schemes and types of contracts which were obtained during the project CERtuS. Also, the results of CERtuS were combined with other EU funded projects with relative topics and so the audience had an overall idea about the nZEB, Financing tools and EPC regarding the public sector. All

the training materials were adapted to the country's needs (legislation, market, etc). The main issues which were discussed were: (i) Technical and economic parameters for developing nZEB projects; (ii) Solutions examined during CERtuS project; (iii) Materials, Systems and RES for nZEB; (iv) Financial models and requirements for project financing; (v) Funding programs; (vi) Cooperation models with energy service companies (ESCo) and types of Energy Performance Contracts (EPC); (vi) Obstacles to the development of EPC in Greece; (vii) Obligations of Greece according to the EU Directives

It is important to mention that all the presentations were live streaming and so the participants could interact with the speakers or with the rest attendees by sending questions or personal experiences from relevant projects

In order to offer continuous support to the municipalities the training materials, the videos, in Greek language, are available on the website of the CERtuS at:
http://certus-project.eu/tools/training-material/athens-webinar-videos/?lang=el
The webinar presentations are available at:
http://certus-project.eu/tools/training-material/athens-webinar-ppt/?lang=el

- Portugal: The training courses in Portugal was implemented in webinar sessions, titled 'Cost Efficient Options and Financing Mechanisms for nearly Zero Energy Renovation of Existing Buildings Stock'.

  The main objectives of the Portuguese training courses were to provide information about: (i) innovative technologies for renewable energy generation and energy efficiency; (ii) obstacles and risks in nZEB renovations, as well as its legal framework; (iii) technical evaluation of nZEB projects; (iv) economic evaluation of nZEB projects; (v) energy services and relevant contracting for nZEB project.

  Therefore, the training courses were divided in three sessions, i/ Renewables and Energy Efficiency Technologies; ii/ Legal Framework and Technical Evaluation; iii/ Economic Evaluation and Energy Services.

  The webinars aimed primarily at the technicians of the Municipalities and the audience was constituted not only by municipalities and local authorities (main from the region), but also by companies (mainly ESCOs) interested in providing services to Municipalities, as well as architects, engineers and researchers that have collaborations with Municipalities.

  The webinar presentations are available at:
  http://certus-project.eu/tools/materiais-de-formacao/apresentacoes-em-portugues/?lang=pt-pt

- Spain: the Spanish capacity building courses addressed mainly the region of Basque country, was conducted online and had the objective of transmitting the knowledge to promote the design of nZEB and enable the implementation of the Directive of Energy Efficiency in Buildings of the municipalities in Spain. The main topics that have been treated concerned: (i) Technologies and innovative

solutions for the energy efficiency; (ii) Economic evaluation and financing models and mechanisms; (iii) Decision making in energetic rehabilitations; (iv) Case studies and good practice; (v) Barriers and challenges that nZEB renovation faces. The training course for Municipalities' technicians took place through three sessions, namely i/ 'Affordable and Adaptable Public Buildings Through Energy Efficient Retrofitting' in collaboration with A2PBEER project of FP7 (www.a2pbeer.eu); ii/ 'Creation of energy-efficient Buildings Renovation Action Plans for cities: guideline and application cases', organized within SE4ALL initiative, in collaboration with NeZeR project (http://www.nezer-project.eu/) of the IEE program; iii/ 'nZEB renovation; packaged solutions, barriers and challenges', in collaboration with NeZeR and ZenN (http://zenn-fp7.eu/) projects.
The videos and the webinar presentations in Spanish language, are available to municipalities' technicians and to all interested on the website of CERtuS at: http://certus-project.eu/downloads/,
WP6,
http://certus-project.eu/tools/workshops/workshop-errenteria/presentations/?lang=es
The training materials can be downloaded at:
http://certus-project.eu/tools/material-de-formacion/presentations/?lang=es

- Italy: The Italian team of CERtuS project offered two distinct training courses, each one with two full days, in different Italian locations, in Central Italy and Sicily. The training courses on "Public Buildings Towards Nearly Zero Energy Buildings - Financing Mechanisms for Energy Recovery" aimed to: (i) Deepen participants' knowledge about the concept of nZEB, the energy efficiency of buildings and the use of renewable energy systems; (ii) Increase awareness of the participants through examples of technical and economic evaluation of nZEB renovation; (iii) Acquire information on the existing funding opportunities, the sustainability and bankability of the projects and the selection of energy services and related contracts; (iv) Learn how to develop successful nZEB projects in the framework of the Italian specific circumstances and environment and other funding initiatives related to local laws and roles.

The agenda of the Italian training courses considered the relevance of the recent seismic events in Central Italy and the fact that it has initiated a process to transform the critical public facilities (schools, hospitals, etc.) in buildings resilient to earthquakes. For this reason, it has been added a topic on nZEB and the use of modern anti-seismic technologies on existing buildings, because (i) the interventions of energy efficient buildings and earthquake resistant buildings have as a common denominator the deep renovation and (ii) the issue of seismic stability is a driver for building renovation.

The first Italian training course was co-organized by the Italian team of the CERtuS project and the Master PARES (University of Rome "Sapienza"), the city of Narni, the National Association of Italian Municipalities (ANCI), the Orders of Architects and the

Order Engineers of the province of Terni. The second one was co-organized by the Italian team of the CERtuS project, the Orders of Architects and Engineers of the province of Messina.

The training materials are available at:
http://certus-project.eu/tools/materiali-per-la-formazione/?lang=it

In general, the feedback from the participants of the courses was quite positive and encouraging. The interest about nZEB is great as most of the participants intending to implement this kind of renovation projects. Regarding the content of the courses and materials, attendees expressed an interest in areas they were unfamiliar with. Thus, professionals whose expertise is in technical solutions expressed a preference for the financial aspects of the workshop. The vast majority of attendees in the four countries expressed its interest for similar future seminars.

4.2 THE IMPACT OF THE RESULTS ACHIEVED DURING THE CERTUS PROJECT

The results of the preliminary impact of the action confirm the feasibility of the deep renovation projects thought the Energy Performance Contracts. Below, are highlighted the most important:

- Two out of four CERtuS Municipalities have made plans to proceed to the renovation of their buildings with tenders launching in the near future:
  - In the Region of Sicily, where the Italian team have deliberately focused on launching the project results, the Municipality of Messina will benefit from the funds, already allocated, of PON METRO, for the energy efficiency of the three pilot buildings of CERtuS project. The renovation of these 3 Italian CERtuS pilots is based on the CERtuS investigations and results. The Municipality will issue the tender for the allocation of the works within 2017. This is a great result for the Municipality and for the whole CERtuS team which contributed to this achievement. It is hoped that this positive experience of the CERtuS pilots in the Municipality of Messina will show the way to other Sicilian Municipalities (common characteristics and legislative aspects) to resolve the funding and the performance issues of their buildings and will accelerate the implementation of the Energy Efficiency. A well-established initial energy efficiency outbreak, can easily 'contaminate' other regions… …
  - The municipality of Alimos is preparing the tenders for a greater number of buildings including the 3 CERtuS pilots, which is expected to be launched in 2018: six more Municipalities from the Region of Attika, including the Municipaliy of Alimos and EUDITI of the CERtuS Greek team have created a consortium targeted the renovation of 116 municipal buildings through a mixture of funding sources including energy performance contracting and other innovative financing mechanisms. The new initiative has been funded by Horizon 2020 through PDA. It is expected that by year 2020 the buildings will be

renovated. This is a very promising activity because the renovated buildings and the financing schemes will act as good examples for replication.

This preliminary but very concrete impact reached during the project life was very ambitious considering the time frame of the project, as two out of four CERtuS Municipalities are already preparing the tenders to be lunched in the near future. There are important signs of similar initiatives from the other two CERtuS municipalities

- The four training activities targeted Municipalities, ESCos and financing entities in the four Southern European Countries noted the positive impact of the training to the public and the willingness to deepen in the CERtuS objectives, as the vast majority of trainees expressed its interest for similar futures seminars. This interest and request involved all CERtuS countries.

5 CONCLUSIONS AND RECOMMENDATIONS

5.1 DESIGN, CONSUMPTION AND PERFORMANCE ASSUMPTIONS

The renovation options for existing buildings should be implemented by group of measures, based on preliminary studies and evaluations and on analyses of their final impact, instead of in advance defined and fixed single measures. These renovation options should include technical and financial actions.

For example, the replacement of windows produces post-required actions (e.g. painting) which affects the building envelope and is related to the additional wall insulation. Moreover, the technical aim of such interventions is the reduction of the heat losses and the improvement of the indoor conditions. So, the additional wall insulation without the replacement of the windows (in some cases):

- it is not as efficient for the reduction of heat losses;
- makes the replacement of the windows a non-financeable solution as they would be installed later. In this case the potential energy reduction will also be estimated on a lower base case scenario (it is referred to the estimated energy consumption after the additional insulation).

Thus, the renovation measures must be based on a carefully determined design and evaluation approach. The total effect of planned measures must have defined on systematic approach.

A renovation option should be totally profitable. Otherwise it could be never implemented, excluding the projects in which other benefits could be reached.

The payback time of energy related renovation is the controlling factor but, in some cases, the longer payback time can be accepted if this prevents risks or material damages and/or obvious structural defects, which could cause bigger investments in the future. Obviously, the value of energy savings of one measure with reasonable payback time can also be combined with a measure of longer payback time if the mixture is technically and economically viable and attractive.

The deep renovation is complex and expensive. Thus, the implementation of energy performance design studies must be addressed through some tasks, giving priority, to:

- The measures which must be carried out because of risks and obvious damages found during the design stage (they can be very expensive later);
- Energy saving measures with zero and low-cost investments and short payback time (e.g. tightening of windows, door, adjusting running time of HVAC and lighting);
- Energy saving measures with reasonable payback time;
- Improvement of the energy efficiency by long-term effective installations, such as RES and hybrid or/and passive systems replacing fossil fuels.

This approach and procedure requires a short- and long-term maintenance plan and also allocation of resources in a way that life-cycle curve of a building will be optimized.

It is very difficult to reach the nZEB threshold by developing projects in public-private partnership at market conditions involving an ESCo.

The investments on the existing buildings tend to focus on measures with short and medium payback period which usually generate around 30%-40% energy savings. This is the current obtainable threshold in the market and varies across the involved countries and building types. Further energy savings are therefore achievable only by increasing investments, that are not always cost-efficient at market conditions and that usually need to be financed with specific ad hoc financial instruments and/or public grant.

In order to make investments which are more sustainable for ESCos, the renovation projects, when possible, could consider alternative ways compared with the standard EPC contract.

For example, to implement other types of contracts, a global service or a direct procurement by the Municipality

Small size energy efficiency projects are not rare in the public sector of Southern European countries. Whereas energy efficiency projects - generally tend to be larger both in investment and in reduction effects - could be a good option to aggregate more than one initiative.

This aggregation could be useful to obtain cost efficiency, incremental revenues and synergies.

Financial barriers are considered by the stakeholders as the main barriers for nZEB renovations.

This fact is worsened, in some cases, by the decreased interest, political decision-making and the shortage of public funds. The promulgation of ambitious energy plans accompanied by suitable tax policy, as well by incentives, is seen necessary to boost energy renovation not only in the majority of the involved countries, but probably also in other South and East European countries.

The lack of knowledge of retrofitting technologies, especially the innovative ones, and the unclear energy policies has been identified as the main barrier from the technical point of view.

Moreover, this lack of knowledge also depends on the absence of credible energy savings data, uncertainty of maintenance costs and complexity of the installations.

When the renovation options are not financially sustainable, is due generally to several factors, as:

- Technological solutions, which are currently available in the market, are quite expensive if compared with the obtained savings costs. This has a negative impact on the economic and financial feasibility of the projects
- The medium and long payback-time of some specific measures
- The additional costs caused by special constructions or systems, required for listed buildings, compared with conventional ones
- Energy efficiency interventions may improve the ability of public authorities to identify the significance of proper maintenance frequency, compared with the conditions before renovation. Usually this will come up when annual maintenance costs increase, (entirely sustained by the ESCO). This aspect - although it initially increases public expenses - is fundamental for the proper maintenance of the new systems.

5.2 RECOMMENDATIONS

In order to encourage nZEB interventions and financing them at market conditions some actions should be considered. Those do not necessary derive from the investigations and other analysis done within the CERtuS project. They are proposed, as stimulus for thinking, concerning the feasibility and sustainability of the nZEB interventions:

- Increase the use of public buildings during the daytime by additional activities, when it is possible (e.g. sport and social activities during the evening/night, office activities during the day). If the use of a building can be extended from a normal/conventional use, it will bring benefits, as the optimisation of the building usability and profitability.
- Increase ESCo services, which, in addition to hard facility management (e.g. mechanical, fire and electrical services), could offer them the possibility to carry out auxiliary services such as soft facility management, (e.g. cleaning services, green care, reception). This would provide additional revenues to the ESCOs, and would make it more attractive.
- At the end of the implementation of the renovation works and when the building has reached the defined requirements and standards and / or when it comes fully operational, a further opportunity to increase energy efficiency interventions could be possible. This deals with the participation of financial institutions (e.g. institutional investors, funds, etc.) investing money into the ESCO.
- Consequently, the ESCo could bring more resources to carry out extra projects. This scheme may solve ESCO’s undercapitalization or decrease their need of financial resources.

CERtuS project promotes the implementation of Energy Efficiency and encourages stakeholders creating business frameworks that are favourable to investments.

CERtuS has adapted existing energy service models and procedures and has identified financing schemes that are suitable for the building projects and the specific requirements of each municipality.

- CERtuS renovation design has succeeded to show that energy consumption for heating, cooling, ventilation and lighting can be significantly reduced with the share of renewable energy. The same principle is in force and achievable in the many cases of the historic buildings, when an interdisciplinary approach, both theoretical and technological, ensure the implementation of quality interventions in accordance with the specific characteristics of the historic buildings.
- CERtuS renovation design, even if innovative, purposefully is not at the forefront. This choice better reflects market conditions, has less risk and is closer to investors' requirements for safe investment options.
- CERtuS has developed a methodology and a Simplified Economic Evaluation Tool, aiming to provide support to municipalities to prepare and evaluate the potential of energy efficiency and deep renovation retrofitting to be financed with an energy service contract.
- CERtuS has developed a methodology which assesses the risk and evaluate the specific requirements for each municipality to identify existing energy service models and procedures and the most suited mix of market money, subsidy funds and grants needed to finance nZEB renovation and energy efficiency interventions.

CERtuS results' replication is facilitated by the development of guidelines and training material, capacity building in municipalities, workshops and web tools.

6 OTHER PROJECT RESULTS

The outcomes produced in the CERtuS project are composed of different project documents. Thirty one out of thirty-five papers produced by the CERtuS consortium have a public nature and are made available to any interested through the project web-site page: www.certus-project.eu.

6.1 CERTUS DOCUMENTS OF PUBLIC INTEREST

Report presenting the 12 nZEB renovation schemes fully documented with technical and economic evaluation.	Presents in detail the 12 nZEB renovation schemes and covers all technical aspects of renovation options of each building of
Report presenting the risks, difficulties and constraints envisaged by the stakeholders regarding nZEB renovations.	Presents the results and conclusions which aim at establishing a framework for a useful renovation process of existing public buildings with high energy efficiency goals. Available in English and translated in IT, GR, PT, ES.
Four documents, one per Municipality, summarizing the obstacles, risks and difficulties for the renovation schemes	Comprises 4 specific papers, one of each involved municipality. The four reports are structured in the same manner and are available in English and translated in IT, GR, PT, ES
Catalogues of materials equipment and technologies pertinent to all municipal buildings.	Summaries the analysis of potential materials, equipment and solutions considered in the project case studies to achieve nZEB.
Twelve economic evaluation reports.	Defines a common economic evaluation methodology for the renovation schemes which considers several aspects and analyses 12 renovation options in order to understand if they are market sustainable, partial market sustainable or no sustainable at market conditions
A report with proposals for regulation improvement.	Summaries an overview of the legislation pertinent to energy efficiency and integration of RES, and documents proposals to regulators on needed regulation improvement to facilitate nZEB renovations, considering also the historic buildings. Available in English and translated in IT, GR, PT, ES
Report of analysis of current conditions for Messina / Alimos / Coimbra / Errenteria	Outlines the economic, legal and policy conditions prevailing in the four Municipalities, relevant to renovation project financing. Available in English and translated in IT, GR, PT, ES.
Report of existing performance contracting examples and energy service models	Reviews the existing energy performance examples and energy service models through: (i) an analysis of the projects funded by IEE; (ii) a survey among partners on the existing EPC and energy service models; (iii) an analysis of energy efficiency building projects realized by ESCo.
Report on suitable energy service options for the four municipalities.	Reports on the most suitable energy service options and describes the adapted energy service schemes with suggestions for each municipality. Available in English and translated in IT, GR, PT, ES
Report on financing mechanisms suitable for each Municipality	focus on those available in the 4 involved Southern countries. Available in English and translated in IT, GR, PT, ES
Report on financing mechanisms suitable for each Municipality	Identifies, analyses and classifies the existing financing schemes for energy efficiency retrofits in public buildings, with a special focus on those available in the 4 involved

	Southern countries. Available in English and translated in IT, HE, PT, ES
Reports: requirements and goals of the web-based information portal & design specifications and blueprint of the portal. (Confidential)	Presents the requirements and goals of the web-based information portal and the design specifications and blueprint of the web-based information portal
Open service-oriented integrated web-based portal in English, IT, ES, PT, GR	Communicates the objectives, results and deliverables of the project to the public and it presents the modifications of the Web portal contents and the new sitemap of CERtuS website.
Portal with information entered in English, IT, ES, PR, GR	Introduces the CERtuS project outputs and other informations on nZEB projects. The Portal is available in English and translated in IT, GR, PT & ES
Training courses handouts	Collects the materials and other outputs developed within the CERtuS project in different modules for the municipality technicians and employees training
Translation and adaptation of training courses handouts in IT, PT, ES, GR	Presents the translation of the materials and other outputs developed within the CERtuS project in different modules for a municipality employees training and adapts them to the local needs
Training courses for municipalities in Greece, Portugal, Spain, Italy	Develops the training courses realization in the 4 countries by the local partners involved in the project
Report on training courses evaluation	Reports on the results of the evaluation of each training course
CERtuS website, logo and project flyer	Introduces and describes the different communication tools of the project. All tools are available in English and translated in IT, HE, PT, ES
Guide	Details the technical options and financial schemes for the Municipalities. The Guide is available in English and translated in IT, GR, PT, ES
Maxi Brochure	Informs and describes the Project and its activities focusing on the model renovation schemes of the twelve pilot buildings. The Maxi Brochure is available in English and translated in IT, GR, PT, ES
Workshop on nZEB energy services and financing in municipalities in Greece, Portugal, Spain and Italy	Presents the examples projects of nZEB renovation and the identified financing schemes with the aim to facilitate better understanding of how results can be used in the CERtuS Municipalities
CERtuS stand at 'Energy Week' 2016	Communicates to the targeted groups via direct personal contacts the existing opportunities for ESCOs and financing Entities in Southern European countries under the current difficult economic conditions

6.2 LINKS OF CERTUS TRAINING COURSES HANDOUT

Handout	Presentation	Slides	Link
Handout 1	1.1 - nZEB Concept, Deep Renovation and Legal Framework	38	http://certus-project.eu/wp-content/uploads/2017/02/1.1-Legal-Framework.pptx
Handout 1	1.2 - Technologies - Renewables	103	http://certus-project.eu/wp-content/uploads/2017/02/1.2-Technologies-Renewables.pptx
Handout 1	1.3 - Technologies - HVAC	90	http://certus-project.eu/wp-content/uploads/2017/02/1.3-Technologies-HVAC.pptx
Handout 1	1.4 - Technologies - Lighting	36	http://certus-project.eu/wp-content/uploads/2017/02/1.4-Technologies-Lighting.pptx
Handout 1	1.5 - Technologies - Control	23	http://certus-project.eu/wp-content/uploads/2017/02/1.5-Technologies-Control.pptx
Handout 1	1.6 - Technologies - ICT	13	http://certus-project.eu/wp-content/uploads/2017/02/1.6-Technologies-ICT.pptx
Handout 1	1.7 - Technologies - Envelope	44	http://certus-project.eu/wp-content/uploads/2017/02/1.7-Technologies-Envelope.pptx
Handout 2	2.1 - Technical Evaluation	214	http://certus-project.eu/wp-content/uploads/2017/02/2.1-Technical-Evaluation.pptx
Handout 2	2.2 - Economic Evaluation	68	http://certus-project.eu/wp-content/uploads/2017/02/2.2-Economic-Evaluation.pptx
Handout 2	2.3 - Obstacles, Risks, Difficulties and Constrains	46	http://certus-project.eu/wp-content/uploads/2017/02/2.3-Obstacles-Risks.pptx
Handout 3	3 - Energy Services	35	http://certus-project.eu/wp-content/uploads/2017/02/3.1-Energy-Services.pptx
Handout 4	4 - Financing Mechanisms	13	http://certus-project.eu/wp-content/uploads/2017/02/4.1-Financing-Mechanisms.pdf

THE CERtuS PROJECT TEAM

ACKNOWLEDGEMENTS

The research leading to these results has received funding from the Intelligent Energy Europe Programme of the European Union under grant agreement IEE/13/906/SI2.675068

Cost Efficient Options and Financing Mechanisms for nearly Zero Energy Renovation of existing Building Stock