EXECUTIVE SUMMARY:

REPORTS PRODUCED UNDER WP5

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RePublic_ZEB Project

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Project consortium

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BRE
BSERC
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URBAN-INCERC
IREC
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WP3 Leader
WP6 Leader
WP2 Leader
Partner
WP1-WP7 Leader
Coordination
Partner
Partner
WP5 Leader
Partner
WP 4 Leader
Partner
Project overview

The RePublic_ZEB project is focused on the energy and CO₂ emissions associated with existing public buildings and their refurbishment towards nZEB.

The **core objective** of the project is to:
- Define costs-benefit optimized “packages of measures” based on efficient and quality-guaranteed technologies for the refurbishment of the public building stock towards nZEB that are standardized and adopted by builders and building owners.

From this stems three **basic objectives**:
(i) State-of-the-art assessment of the public building stock through a country-specific evaluation of the energy consumption and CO₂ emissions;
(ii) Define reference buildings; and;
(iii) Develop a common framework and a harmonized methodology for the definition of a nZEB concept for public buildings.

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Executive Summary

This document is one of a series of executive summary of the core deliverables of the RePublic_ZEB project. This is a summary of all the deliverables in Work Package (WP) 5. The flow chart below shows its context in the overall project.

This is a summary of all the reports produced under WP5:

1. nZEB approach for existing public building and energy recommendations for local or regional authorities, energy agencies, EPC providers
2. Guidelines on best practice for stakeholders and target groups (industries, housing organizations, owners of large building stocks, developers)
3. “Memorandum of understanding” between builders and public building owner representatives (local administrations)
4. Model contract between builders and public building owners for nZEB refurbishment
5. Financing schemes by third parties for builders and building owners, based on the use of packages of energy efficiency measures suitable for nZEB refurbishment
6. On-line municipal counter giving information and connecting stakeholders involved in the nZEB renovation process
1. Report 1: nZEB approach and energy recommendations

The principal objective of this output was to report on current nZEB approaches and definitions for existing public buildings and to make recommendations for local and regional authorities, energy agencies and EPC providers to raise awareness and accelerate refurbishment to nZEB.

The first part of the report presents an update of the project’s approach to the concept of nZEB in a structured and concise way according to: i) General framework for the nZEB definition for each building type; ii) nZEB requirements for new buildings; iii) nZEB requirements for the refurbishment of existing buildings; iv) implementation of the cost-optimal methodology. Overall, five project countries do not currently have an nZEB definition (Greece, Macedonia, Portugal, Spain and UK).

The second part of the report presents recommendations for local or regional authorities, energy agencies and EPC providers in each partner country. These recommendations are structured around:

- Regulations
- Economic incentives and financing instruments
- Energy performance certificates’ use and layout in relation to nZEB standard
- Supervision (energy advice and audits)
- Information
- Demonstration
- Training
- Recommendations

They are based on feedback from the supporting activities, in particular through “one to one” meetings. Each partner was encouraged to develop “one to one” meetings with public authorities during project development, in order to ensure regular contact between the project partners and the public authorities. In the first meeting the project was introduced, while in the second and third meetings the project results were presented and discussed.

The principal objective of these meetings was to establish a regular contact between the project partner and the representatives of the authorities so as to keep them updated about the project results. Overall over 30 “one to one” meetings took place which contributed towards nZEB policy development in the partner countries, particularly Italy where it led to the development of a funding mechanism for the refurbishment of public buildings.

In addition to these “one to one” meetings there were training and dissemination days for all stakeholders which contributed significantly to the overall engagement activity of RePublic_ZEB. These reached nearly 1700 individuals (in 20 groups) as summarized in Table 1 below:
### Table 1. Summary of training and engagement activities

<table>
<thead>
<tr>
<th>Partner</th>
<th>M1</th>
<th>M2</th>
<th>M3</th>
<th>Joined events</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Training meeting</td>
<td>No. of participants</td>
<td>Meeting between builders and public owners</td>
<td>No. of participants</td>
</tr>
<tr>
<td>BSERC</td>
<td>✓</td>
<td>34</td>
<td>✓</td>
<td>50</td>
</tr>
<tr>
<td>EIHP</td>
<td>-</td>
<td>105</td>
<td>-</td>
<td>-</td>
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<td>15</td>
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<td>CRES</td>
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<td>60</td>
<td>✓</td>
<td>80</td>
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<td>✓</td>
<td>63</td>
</tr>
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<td>CTI/POLIT O</td>
<td>✓</td>
<td>64</td>
<td>✓</td>
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<td>LNEG</td>
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<td>129</td>
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<td>URBAN-INCERC</td>
<td>39</td>
<td></td>
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<td>68</td>
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<td>ZRMK</td>
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</tr>
<tr>
<td>IREC</td>
<td>✓</td>
<td>156</td>
<td>✓</td>
<td>14</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>698</td>
<td></td>
<td>546</td>
<td>431</td>
</tr>
</tbody>
</table>
2. Report 2: Best practice guidelines

The objective of this report is to promote the packages of measures that will deliver nZEB refurbishment to a wide range of stakeholders, and to engage with them to develop memoranda of understanding (MOUs) and model contracts. This will help increase the uptake of the packages of measures and an increase in nZEB.

The report is focused on promoting best practice to stakeholders and so provides the definition of nZEB adopted by the project in the context of cost-optimal building refurbishment and to show that the packages of measures are cost-effective.

It also provides a description of the reference buildings from a range of project partners to show their energy performance before and after refurbishment, the package of measures adopted, the breakdown of energy consumption and the associated global costs. An example of this is given in Figure 1 below.

Figure 1. Example of reference building case study with package of measures

Figure 2 shows the range of energy efficiency measures as applied to a selection of reference buildings as an optimised package of measures together with a summary of primary energy consumption broken down by project country and building category.
The report also contains a technical description of all of the individual energy efficiency measures together with a quantitative/qualitative ranking across the metrics: energy saving potential, environmental impact, comfort improvements, capital cost, maintenance cost and payback. In addition it highlights the benefits and limitations/risk of each technology.

Although there are key differences between countries arising from, for example, different typologies, climate and occupancies, the strategies to achieve the nZEB criteria are very similar. In fact, the measures that have been selected in most of the buildings are:

**M1 - Thermal insulation.** This measure has been adopted in most of the buildings and is applied to: facade, walls and slabs separating conditioned and unconditioned rooms, roof and floor. Despite their high investment costs, this measure is the most effective in terms of energy demand reduction. Thermal insulation reduces the heating and cooling demand as well as thermal bridges of the building. Its sizing is dependent on the climate (more insulation in colder climates).

**M2 - Efficient windows.** This measure is one of the most effective measures. The investment cost is high but the benefits are significant. There are many types of efficient windows and the selection depends on the climate and the overall design of the building: heat gains, solar shading devices (M3), daylighting control have to be considered too.

**M16 - Photovoltaic system.** A PV system is the most popular renewable energy system due to the simplicity of the installation and the benefits in terms of reduction of electric consumption.

**M17 - Efficient lighting.** Artificial lighting has a significant impact on the energy balance and the adoption of efficient lamps also provides positive impact from an economic point of view. The most common solutions are LED technologies and fluorescent lamps T5, combined with control strategies (M18).

**M18 - Management/control systems.** To ensure a proper operation of the systems it is very important to manage the building with advanced tools, such as building management systems.
and optimal control strategies. There are different levels of implementation, depending on the needs and features of the building.

Regarding heating, cooling and domestic hot water systems, the selection of efficient systems is more flexible and depends on the existing services in the building and its location. The most common technologies are:

- **M5 - Biomass boiler.** This technology has been adopted in large buildings, where the heating and the sanitary hot water production must be provided by the boiler. This system is best suited to cool climates or in buildings with a high energy demand (for example, the hospital).
- **M7 - Air source heat pump.** The air source electric heat pump has been chosen in several building categories and climates, where more services have to be provided (only heating; heating and cooling; heating, cooling and hot water). The technical and economic feasibility and the reliability of heat pumps is increasing and this makes the technology very flexible today. It is also an ideal technology to be combined with electric renewable generators. The use of geothermal (ground source) and water heat pumps (M8) depends on the location of the building and is less generalizable.
- **M12 Mechanical ventilation.** The system controls the rate of air replenishment and ensuring good indoor air quality. However, greater energy savings require combining it with additional measures: advanced control systems (M18) and heat recovery systems (M13).

As a final remark, it important to underline that the energy diagnosis and an overall assessment of the existing building are a very substantial step in the design of the retrofit measures. In fact, the transformation towards nZEB is, in the end, an energy and an economic issue based on the energy balance of the building. This means reducing energy needs, improving efficiencies in general and increasing the use of renewables taking into consideration the characteristics of the building and the local climate.

However, other aspects must be considered in refurbishments, e.g. thermal comfort, the rationalization of the use of the building, eventual artistic demands (often required in public buildings by local planning regulations) and the preservation of historic value (this is a very significant issue in ancient cities and town) etc. These aspects should not be forgotten when developing refurbishment packages.
3. Report 3: Memoranda of understanding

One of RePublic_ZEB’s objectives was to establish connections between public building owners (public administrations in general) with stakeholders (builders, ESCOs, other companies) who are able to undertake renovations of public buildings to nZEB, with the aim to accelerate specific refurbishment projects of buildings.

As an “instrument” to connect the key stakeholders, the project proposed a “Memorandum of Understanding - MoU” with the objective to have 1-2 documents signed in each of the participating countries.

The experience gathered by the partners during the action and the discussions held during project meetings it was agreed to include within the MoUs: informative activities, feasibility studies and/or different actions to approach the general issue (i.e. how to refurbish a building to nZEB). This task encountered various difficulties:

- Public building owners are public administrations who are required to follow a precise bureaucratic processes. Any direct agreement with specific private subjects (like the key stakeholders mentioned above) qualifies as a first step that bypasses public tender procedures. Therefore, the initial idea of a MoU focussed on specific refurbishment projects ran into this problem as administrations are bound by administrative processes.

- Awareness of renovation of public buildings to nZEB was much lower than expected for both public building owners as well as professional and industrial stakeholders. Most of the actors asked for targeted start-up activities, focussed on specific topics, such as insights on the packages of energy efficiency measures and feasibility studies on specific buildings.

- Last but not least, this general need of “targeted information” arises because the normative (and legal) definition of nZEB is non-existent, vague or inconsistent in some countries and is too new in others. This results in a cautious approach by the key actors, considering also the high level on investment required by refurbishment projects, particularly nZEB ones.

Because of this, the main purpose of the final MoU template that was prepared in the framework of the recognition of the strategic importance of sharing robust information between building owners, builders and in general all professional groups involved in the process of refurbishment to nZEB:
Memorandum of Understanding

Between

(Partner)

and

(Partner)

This Memorandum of Understanding (MOU) sets for the terms and understanding between the (partner) and the (partner) to (insert activity).

Background

Reducing the building energy consumption to "nearly zero" level is one of the priority directions towards finding modern solutions for improving the energy performance of the building sector. In accordance with Directive 2010/31/EC, the Member States shall draw up national action plans for increasing the number of "nearly zero-energy buildings", including policies and measures to stimulate the refurbishment of the existing building stock into "nearly zero-energy buildings - nZEB".

In particular, public buildings refurbished into nZEB can act as exemplars of new solutions: since they are normally open to the public. The public buildings can have also a very important role in creating public and social acceptance of nZEB and in educating building owners and users, professionals, installers and builders.

The main barriers to the refurbishment of buildings to nZEB are: the high capital cost needed for this type of refurbishment and limited experience and confidence in nZEB, especially of building owners and contractors (builders), as well as professionals, installers and other stakeholders.

There are two key points:

- builders need to understand that achieving nZEB requires the optimal combination of several techniques/technologies (solutions) rather than a single technique / technology;
- building owners and builders depend on the real energy performance and the financial payback of the proposed nZEB solutions to enable them to make a concrete offer to/demand on the market that can overcome the high up-front capital cost. In fact, by increasing confidence in the final result and minimizing the relevant risks, the chances of securing private finance also improve (i.e. this could allow an ESCO to become involved).

Purpose

The main purpose of this MOU is to promote refurbishment projects. The starting point is the recognition of the strategic importance of sharing robust information between building owners, builders and in general all the professional groups involved in the process of refurbishment to nZEB.

The above goal will be accomplished by undertaking the following activity/ies:
(To avoid any doubt and to ensure both parties are clear what is expected it is a good idea to describe the activity/ies that are planned for the partnership and who will do what)

**Funding**

*(Specify if this MOU require or not a commitment of funds by either partner)*

**Signature of the Partner Organization A**

Public Building owner; association of public building owners; local/national authorities in charge of the management of public buildings

**Signature of the Partner Organization B**

Builder, Association of Builders, ESCO; association of ESCOs; association of professionals... as a last resource the project partner

All the project partners (Bulgaria, Croatia, Former Yugoslav Republic of Macedonia, Greece, Hungary, Italy, Portugal, Romania, Slovenia, Spain - Catalonia Region) then adapted and translated the text to their specific needs. Table 2 below summarises the signed MoUs across the project partners:

<table>
<thead>
<tr>
<th>Partner</th>
<th>Number of documents forming the MoU</th>
<th>Signed in time</th>
<th>Under signature at the closing time of this report</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Number of signing persons</td>
<td>Number of Signing organisations</td>
</tr>
<tr>
<td>BSERC (BG)</td>
<td>42</td>
<td>42</td>
<td>33</td>
</tr>
<tr>
<td>EIHP (HR)</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>MACEF (MK)</td>
<td>16</td>
<td>16</td>
<td>13</td>
</tr>
<tr>
<td>CRES (GR)</td>
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<td>9</td>
<td>9</td>
</tr>
<tr>
<td>BME (HU)</td>
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<td>5</td>
<td>5</td>
</tr>
<tr>
<td>CTI/POLITO (IT)</td>
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<td>4</td>
<td>4</td>
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<tr>
<td>LNEG (PT)</td>
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<td>13</td>
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<td>-</td>
</tr>
<tr>
<td>ZRMK (SLO)</td>
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<td>27</td>
</tr>
<tr>
<td>IREC (SP)</td>
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<td>2</td>
<td>2</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td><strong>7</strong></td>
<td><strong>122</strong></td>
<td><strong>105</strong></td>
</tr>
</tbody>
</table>

*Table 2. Breakdown of MoUs signed in the RePublic_ZEB project*
4. Reports 4&5: Model Contracts and finance schemes

This report is Reports 4 & 5 combined because the subject of energy performance contracts is closely related to the issue of financial schemes.

According to the European Commission Joint Research Centre, Institute for Energy and Transport (IET) an “Energy Performance Contracting (EPC) is a form of “creative financing” for capital improvement which allows funding energy upgrades from cost reductions. Under an EPC arrangement an external organization (ESCo) implements a project to deliver energy efficiency or a renewable energy project, and uses the stream of income from the cost savings or the renewable energy produced, to repay the costs of the project, including the costs of the investment. Essentially the ESCo will not receive its payment unless the project delivers energy savings as expected”.

The energy service market for the refurbishment of buildings is a key issue for public administrations without the capital for projects to transform existing buildings towards nZEB. In this context, the main aim of this document is to set out the state of the art for EPC contracts (which is not well developed yet) and for the financial instruments available in each country.

The first report (Report 4) contains an annex that can be included in EPC contracts between builders (ESCos in this case) and public building owners to refurbish buildings. The template, based on RePublic_ZEB approaches and findings discussed in the previous deliverables, is supported by the contributions of the participating countries.

In most countries, model contracts between public building owners and ESCOs / builders already exist, and so the report provides useful input to improve these models and/or provide information for their technical annexes.

The second report (Report 5) features information gathered by the partners on national financing schemes and instruments to refurbish buildings and public buildings. Considering that there are very few funding schemes dedicated to nZEB, the topic is covered in a general way.
5. Report 6: On-line counters

As a follow-up activity of the meetings held in the different countries (see Table 1), the partners developed on-line "counters", i.e. national information points which provided documentation presented in seminars, workshops and articles to increase the involvement of the stakeholders. The on-line counter and the documentation is generally provided in national languages to facilitate communication of the project results.

An important role for the “counters” is to act as a reference for the stakeholders (public institutions, owners, managers, professionals, technicians, builders etc.) to obtain the information and the outcomes obtained in the framework of the RePublic_ZEB project, in particular:

- Public building stock characterization.
- Implementation of the cost-optimal methodology promoted by the European Commission.
- Energy efficiency measures proposed to achieve nZEB, in different building categories, countries and climates.

The objective of this working paper is to collect the initiatives carried out in every country, including a brief overview of the online counter:

<table>
<thead>
<tr>
<th>Country</th>
<th>Website (online counter location)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bulgaria</td>
<td>Black Sea Regional Energy Centre (BSREC)</td>
</tr>
<tr>
<td>Croatia</td>
<td>Energy Institute Hrvoje Požar (EIHP)</td>
</tr>
<tr>
<td>Former Yugoslav Republic of Macedonia</td>
<td>Macedonian Center for Energy Efficiency (MACEF)</td>
</tr>
<tr>
<td>Greece</td>
<td>Centre for Renewable Energy Sources and Saving (CRES)</td>
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<td>Hungary</td>
<td>Budapest University of Technology and Economics (BME)</td>
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<td>Italy</td>
<td>Comitato Termotecnico Italiano (CTI)</td>
</tr>
<tr>
<td>Portugal</td>
<td>Laboratório Nacional de Energia e Geologia (LNEG)</td>
</tr>
<tr>
<td>Romania</td>
<td>Institutul National de Cercetare-Dezvoltare in Constructii, Urbanism si Dezvoltare Teritoriala Durabila (INCERC)</td>
</tr>
<tr>
<td>Slovenia</td>
<td>ZRMK Building and Civil Engineering Institute</td>
</tr>
<tr>
<td>Spain</td>
<td>Institut Catala d’Energia (ICAEN)</td>
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