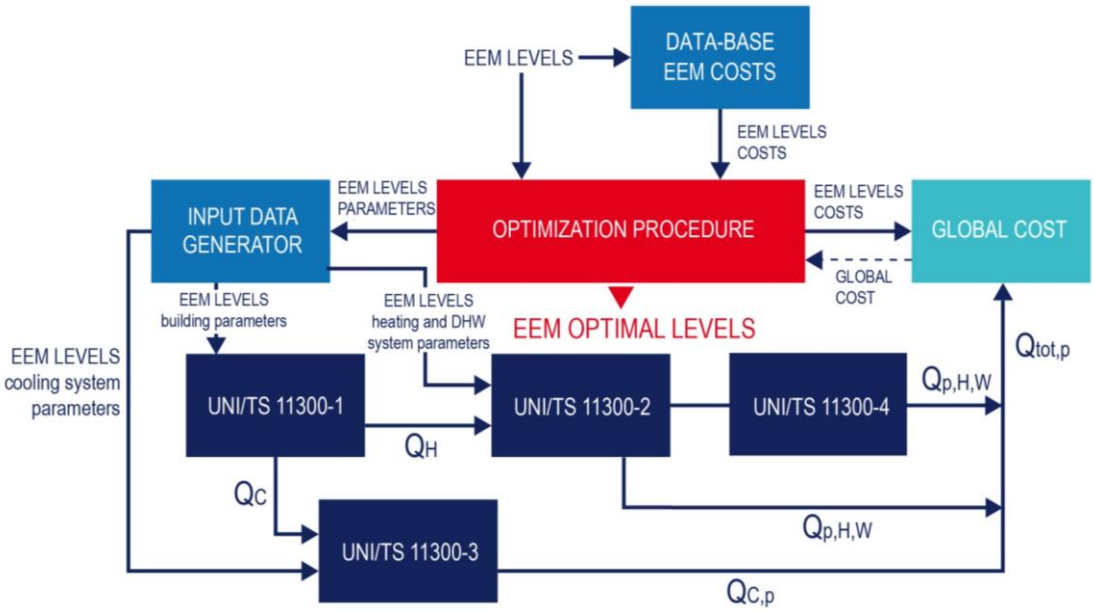
RePublic_ZEB
ZEROING IN ON ENERGY

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

EXECUTIVE SUMMARY:

COUNTRY ASSUMPTIONS FOR THE APPLICATION OF THE COST OPTIMAL METHODOLOGY TO THE REFERENCE BUILDINGS



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RePublic_ZEB Project

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Website: www.republiczeb.org

Project consortium

BME	WP3 Leader
BRE	WP6 Leader
BSERC	WP2 Leader
CRES	Partner
CTI	WP1-WP7 Leader Coordination
EIHP	Partner
URBAN-INCERC	Partner
IREC	Partner
LNEG	WP5 Leader
MACEF	Partner
POLITO	WP 4 Leader
ZRMK	Partner

Project overview

The RePublic_ZEB project is focused on the energy and CO_2 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 CO_2 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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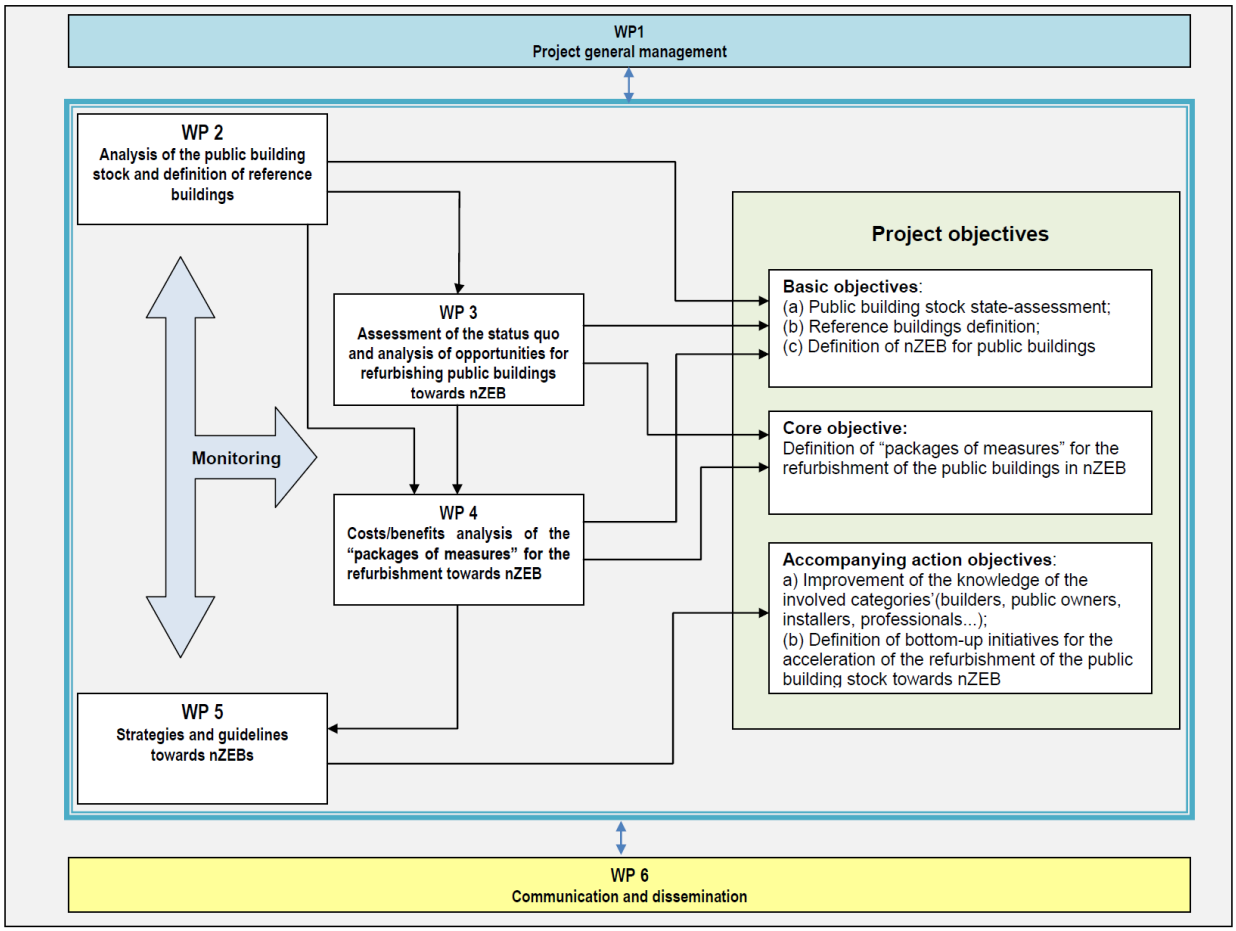
Legal Notice

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 second deliverable in Work Package (WP) 4. The flow chart below shows its context in the overall project.



1. Objective

The objectives of this report are to:

- Define nZEB to be used in RePublic_ZEB to model the performance of refurbished reference buildings
- Compile the cost assumptions used by each project partner/country to undertake the global cost calculation.

2. nZEB definition

A key aim of the RePublic_ZEB project is to identify for each reference building the most suitable packages of energy efficiency measures in order to achieve the nZEB goal. This was done using the common tool. For the purposes of the project, a building is considered as nearly zero energy when:

a) the energy performance (EP) is lower than the cost-optimal level (i.e. a nZEB is more energy efficient than the cost-optimal building);

b) the differential Global Cost (ΔGC) is negative (i.e. nZEB is cost-effective);

c) the national minimum EP requirements for nZEBs are met.

See Figure 1. In this context:

- The *Energy Performance* (as specified in prEN ISO/DIS 52000-1:2015) is expressed as the building *global primary energy demand* divided by the *conditioned area*. The *global* primary energy refers to all the EPBD energy services (heating, cooling, DHW, ventilation, lighting) and is calculated according to the Standard. EP can either include non-renewable energy (EP_{nren}) only, or include both non-renewable energy and renewable energy (EP_{tot}):

  $$EP_{tot} = EP_{nren} + EP_{ren}$$

- The Renewable Energy Ratio (RER) is the ratio of the renewable primary energy to the total primary energy:

  $$RER = EP_{ren} / EP_{tot}$$

- The Energy Performance is fully described by two indicators:
  EP_{tot} and EP_{nren}, or alternatively

  EP_{tot} and RER

- The *Global Cost* (GC) is the net present value of all costs (referenced to the starting year), determined according to EN 15459. The Global Cost is linked to the calculation period (usually 30 years) and includes investment costs for refurbishment; replacement costs; running annual costs. The differential Global Cost (ΔGC) is the extra cost with respect to a baseline building which is the existing (pre-refurbishment) building.

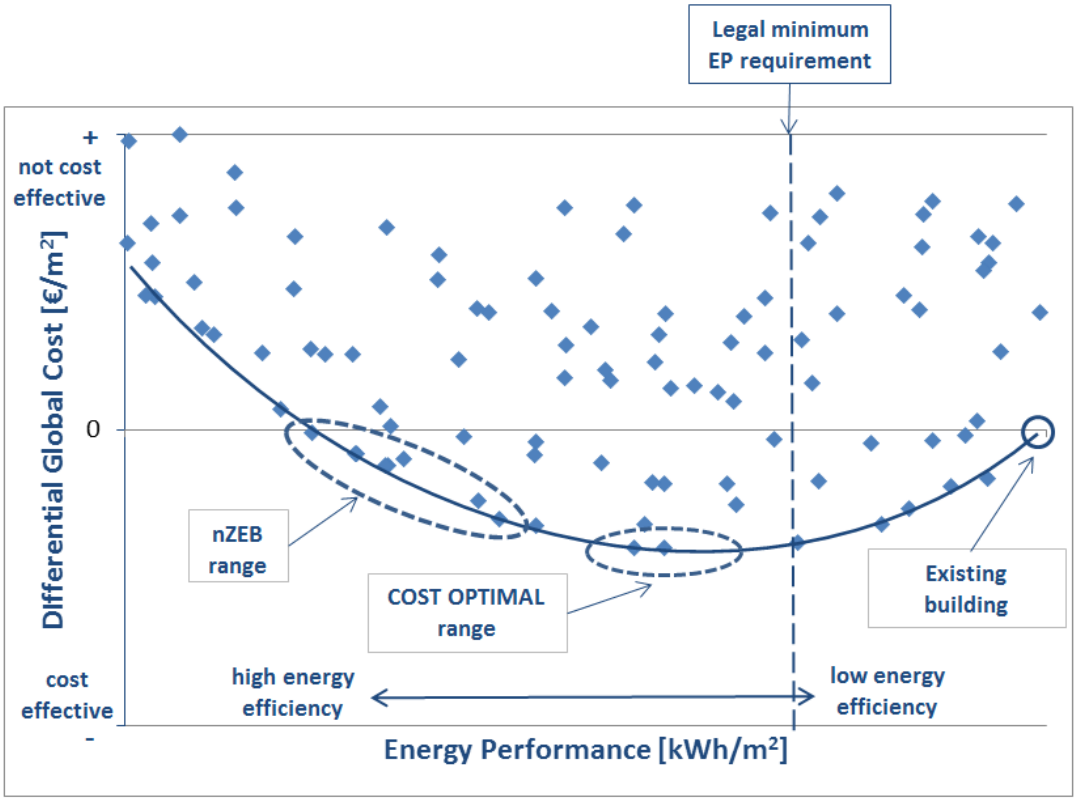


Figure 1. Differential Global Cost versus Energy Performance

In principle, a large number of measures and variants can be considered using the common tool: each point in Figure 1 represents a package of energy efficient measures.

3. Global Cost calculation

The Commission Delegated Regulation No. 244/2012 requires the evaluation of the cost-optimal level both at a macroeconomic and at a financial level. At the financial level, the calculation is based on the overall costs, considering the initial investment, the sum of the annual costs for each year (energy, maintenance, operation and any additional costs), the replacement of systems and components, the final value, and the costs of disposal, as appropriate. All costs are actualized to the starting year.

For RePublic_ZEB purposes, the financial calculation was applied without considering subsidies given that they can change rapidly.

The energy renovation costs have been evaluated by a full-cost approach, including design, purchase of building elements, connection to suppliers, installation and commissioning process. These costs taking into account the cost of ancillary works, e.g. scaffolding of a new chimney, professional fees and taxes.

The replacement costs are those needed to substitute components or systems at the end of their lifespan. Annex A of EN 15459 was used as a reference to define lifespan, which is the economic lifetime expectancy for a component or a system. The running costs include maintenance, operational and energy costs for the time step considered.

Figure 2 summarises this:

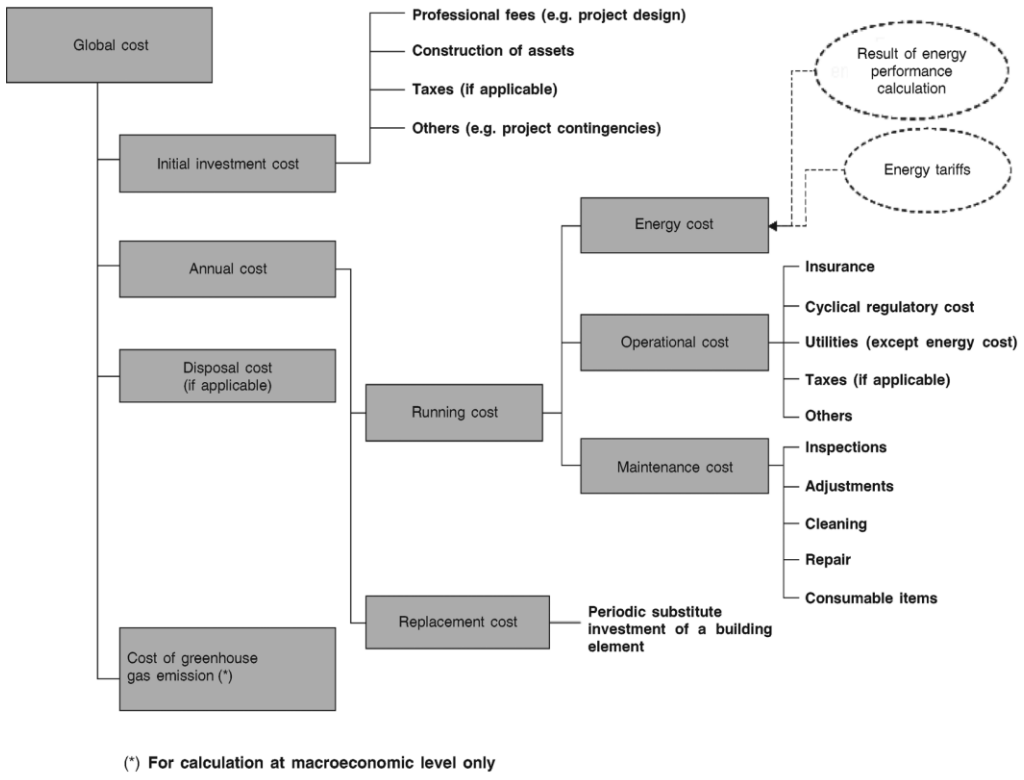


Figure 2. Cost categorization according to the framework methodology

The discount factor for every year, is a factor used to convert a cash flow occurring at a given point in time to its equivalent value at the starting year. According to the Guidelines accompanying the Regulation, a higher discount rate – typically higher than 4% excluding inflation – reflects a commercial, short-term approach to the valuation of investments. A lower rate – typically ranging from 2% to 4% excluding inflation – reflects the benefits that energy efficiency investments bring to building occupants over the entire investment's lifetime. The discount rate is set at country level.

The calculation period was set at 30 years for public buildings, according to the Regulation.

4. Country assumptions

In order to undertake the Global Cost calculation illustrated in Figure 2 each partner compiled cost data and assumptions for their country as taken from market surveys or from official databases. All of this information was required to run the common tool for each reference building.

4.1 Initial investment costs

Capital costs (€, €/m^2 or €/kW as appropriate) were provided for each level of each energy efficiency measure as applied to each reference building. The report has an extensive appendix containing tables of such measures as defined. Table 1 below is an example of such a table for a Bulgarian school.

						Level of EEO					Level of EEO					
						1	2	3	4	5	1	2	3	4	5	
No.	**EEM**	**No. paramaters**	**Parameter**	**Symbol**	**No. EEO**	**Parameter values**					**Cost of EEM**					
1	Thermal insulation of external walls	1	Thermal transmittance	Uw	3	0.25	0.22	0.15			36	38	40			€/m2
2	Thermal insulation of roof	1	Thermal transmittance	Ur	3	0.28	0.22	0.15			25	28	40			€/m2
3	Replacement of windows	1	Thermal transmittance	Uwin	3	1.4	1.1	0.9			75	85	105			€/m2
4	High efficiency generator for space heating (GHS)	1	Generator efficiency at design conditions	η_{gn}	3	0.88	0.93	1.03			50	74	116			€/kW
5	Heat pump for heating	2	Coefficient of performance at design conditions	COP	3	4	5	5.5			1080	1292	1576			€/kW
6	Heat pump for ventilation (heating)	2	Coefficient of performance at design conditions	COP	3	3.5	4	4.5			423	500	550			€/kW
7	Geothermal heat pump	1	Coefficient of performance at design conditions	COP	1	5					692					€/kW
8	Heat recovery ventilation system (HRVS)	1	Heat recovery efficiency	η_r	1	0.7					3150					€
9	Improving the Lighting System (ILS)	1	Simultaneous power (LED based system) including automatic control		1						11037					€

Table 1. Performance levels and cost for energy efficiency measures in Bulgarian school

In addition, the appendix contains compatibility matrices which specify whether particular measures can be applied together when running the common tool. If not then such a combination would not be considered as a package of measures.

4.2 Running costs: operational and maintenance

Maintenance costs for building components and systems were expressed as a % of capital costs. Table 2 below gives an example of the costs for maintaining building components and technical systems in Bulgaria.

BUILDING COMPONENTS	Maintenance cost [%]
External wall thermal insulation	0%
Roof/Upper floor	0%
Ground floor	0%
Window thermal insulation	1%
Solar shading systems	1%

BUILDING TECHNICAL SYSTEMS	Maintenance cost [%]
Central heating system	1%
Chiller	3%
Boiler	1.5%
Heat pump	3%
Solar collectors	1.0%
Recovery ventilation system	4.0%
LED with control	2.0%

Table 2. Building components and technical systems maintenance in Bulgaria

Energy costs (€/kWh) for, ostensibly, gas and electricity were provided for each country and these were used in the common tool. Each partner provided context in terms of pricing structure, predicted price rises etc. By way of an example, Table 3 shows electricity tariffs in Bulgaria.

		CEZ	EVN	Energo-Pro	Golden sands
		EUR/kWh	EUR/kWh	EUR/kWh	EUR/kWh
Three scales	Peak	0.10519	0.10938	0.13705	0,11324
	Day	0.06494	0.07276	0.07832	0,05305
	Night	0.03662	0.03909	0.03360	0,01708
Two scales	Day	0.09329	0.08903	0.09782	0,08049
	Night	0.03865	0.03762	0.03654	0,01525
One scale		0,08062	0.08940	0.09149	0.07617

Table 3. Electricity tariffs for non-domestic users in Bulgaria

Finally, each partner/country provided lifespans for building components and systems as well as the discount rates to be used in calculations.