Implementing Cost-optimal Methodology in Existing Public Buildings

L. Aelenei[a], S. Paduos[b], H. Petran[c], J. Tarrés[d], A. Ferreira[a], V. Corrado[b], S. Camelo[a], E. Polychroni[e], K. Sfakianaki[e], H. Gonçalves[a], J. Salom[d], G. Riva[f], G. Murano[f]

[a]LNEG, Paço do Lumiar 22, Lisbon, 1649-038, Portugal
[b]POLITO, C.so Duca degli Abruzzi 24, 10129, Torino, Italy
[c]URBAN-INCERC, Sos. Pantelimon266, 021652 Bucharest, Romania
[d]IREC, Josep Pla 2, B2, Ground floor, 08019, Barcelona,SPAIN
[e]CRES,19th klm Marathonos Ave., GR 190 09 Pikermi, Greece
[f]CTI, via Scarlatti, 29, Milano, 20124, Italy

Building Physics for a Sustainable Built Environment

6th IBPC
Torino
14-17 June 2015

SUMMARY

- Project RePublic_ZEB
- Building applied concepts/methodologies: cost-optimal
- Cost-optimal framework
- Results and conclusions

RePublic_ZEB

REfurbishment of the PUBLIC building stock towards nZEB

March 2014 – August 2016

Coordination:

CTI (Italian Thermotechnical Committee Energy and Environment)

Partners

PROJECT STRUCTURE

WP1 Mangement
(Lead by CTI)

WP2 Analysis of the public building stock and definition of reference buildings
(Lead: BSERC)

WP3 Assessment of the status quo and analysis of opportunities for refurbishing public buildings towards nZEB
(Lead: BME)

WP4 Costs/benefits analysis of the “packages of measures” for the refurbishment towards nZEB
(Lead: POLITO)

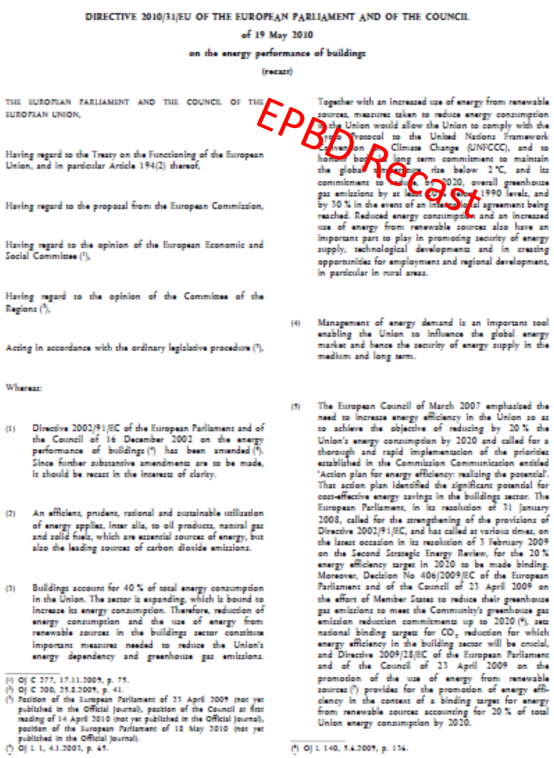
WP5 Strategies and guidelines towards nZEBs
(Lead: LNEG)

WP6 Communication and dissemination
(Lead: BRE)

PROJECT WEBPAGE

http://www.republiczeb.org/

APPLIED CONCEPTS



DIRECTIVE 2010/31/EU OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL

of 19 May 2010

on the energy performance of buildings

(recast)

Article 5

Calculation of cost-optimal levels of minimum energy performance requirements

- The Commission shall establish a comparative methodology framework for calculating cost-optimal levels of minimum energy performance requirements for buildings and building elements
- Member States shall calculate cost-optimal levels of minimum energy performance requirements

COST-OPTIMAL METHODOLOGY FRAMEWORK

Guidelines accompanying Commission Delegated Regulation (EU) No 244/2012 of 16 January 2012 supplementing Directive 2010/31/EU

- define reference buildings (both residential and tertiary sectors, both existing and new), representative of the building stock in terms of function and climatic conditions;
- define the energy efficiency measures (EEMs) to be assessed for the reference buildings, extended to the whole building or to building elements;
- evaluate the final and primary energy need for the reference buildings before and after the realization of EEMs;
- calculate the costs of EEMs applied to the reference buildings in the expected economic life-cycle.

COST-OPTIMAL METHODOLOGY FRAMEWORK

Reference building

- Common for all target countries: Portugal, Italy, Spain, Romania, Greece
- Office public building
- Different climatic conditions: Lisbon, Milano, Barcelona, Bucharest, Athens

Main parameters of the case study-reference building

Geometrical data			Building construction data			System data (mean seasonal values)		
Vg	[m3]	7200	Uwl	[Wm-2K-1]	0,76	Convectors	ηH,e	0,93
Af,n	[m2]	2007	Uw	[Wm-2K-1]	3,20	Room temperature control	ηH,c	0,94
Aenv/Vg	[m-1]	0,32	ggl,n	[-]	0,75	Central distribution (horizontal pipes)	ηH,d	0,98
Aw	[m2]	488,47	Ufl,up	[Wm-2K-1]	0,85	Natural gas standard generator	ηH,gn	0,876
No. floors	[-]	5	Ufl,lw	[Wm-2K-1]	0,25	Electrical storage water heater	ηW,gn	0,75
						Indoor units split systems	ηC,e	0,97

COST-OPTIMAL METHODOLOGY FRAMEWORK

Energy performance assessment

- EN 15603:2008
- EN ISO 13790:2008

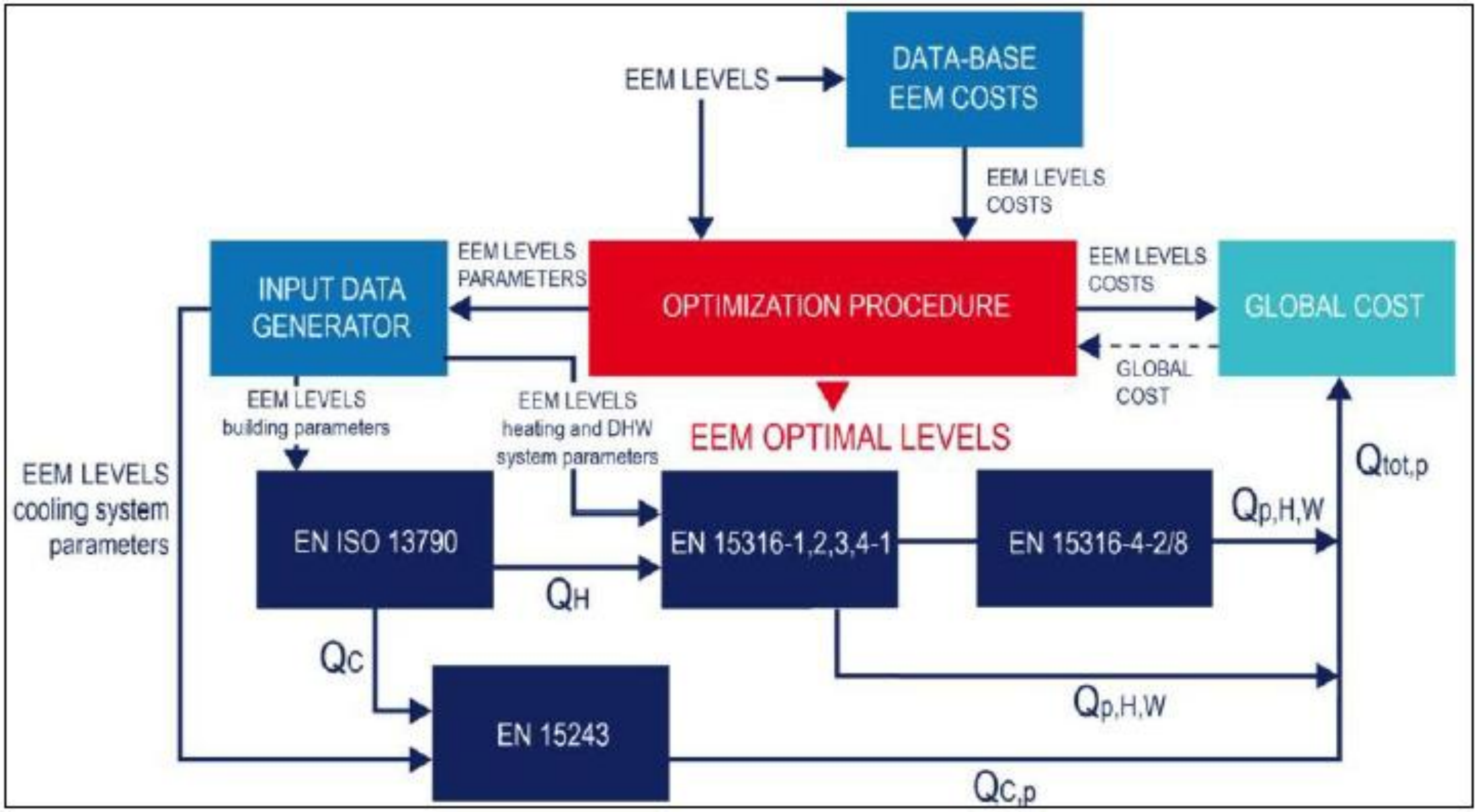
Global cost evaluation - EN 15459:2007

$$C_g(t) = C_I + \sum_j \left[\sum_{i=1}^{t} \left(C_{a,i}(j) \cdot R_{disc}(i) \right) - Val_{F,t}(j) \right]$$

global cost Cg(t) referred to the starting year t0 may be performed by a component or system approach,
initial investment CI, and for every component or system j,
the **annual costs Ca** and the discount rate **Rdisc(i)** for every year i (referred to the starting year), the **final value Val**

COST-OPTIMAL METHODOLOGY FRAMEWORK

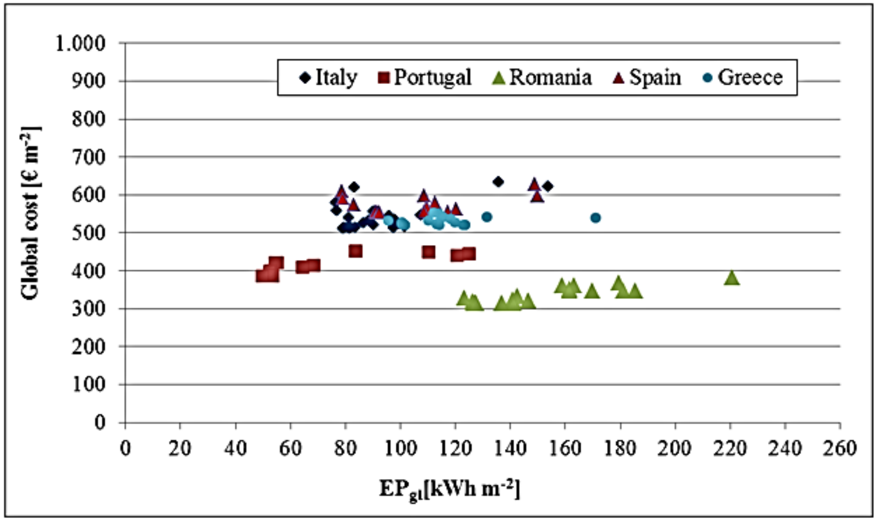
The evaluation tool uses a new cost optimization procedure based on a sequential search-optimization technique considering discrete options is applied



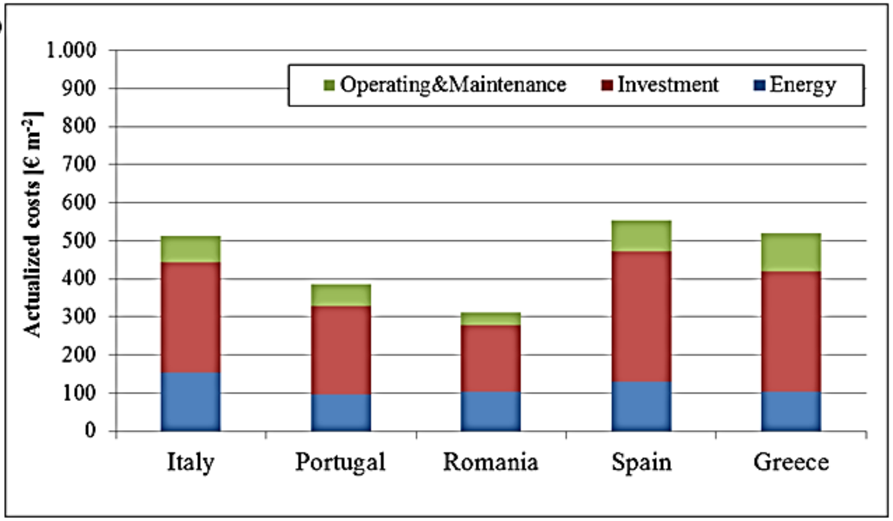
RESULTS

The cost optimization was applied to the common reference case study considering the differences between the five countries in terms of: EEMs, weather data (Milano, Lisbon, Bucharest, Barcelona and Athens), energy price and primary energy indicators per energy carrier

a



b



(a) Optimization procedure application; (b) Cost optimal solution actualized costs

Results and Conclusions

- Concerning the global cost, for Italy, Spain and Greece the value is higher than 500 € m-2, while Romania shows the lowest value;
- Italy and Spain the energy costs are higher than the other countries; in Spain the EEMs costs are also high, while Romania obtains the lowest values in terms of energy, investments and maintenance costs;
- Global primary energy consumption ranges in between 54 kWh m-2 for Portugal and 137 kWh m-2 for Romania;
- Results show a relevant difference among the considered countries in the total primary energy consumption values, against a global cost deviation between 300 and 550 € m-2.

The study highlights the importance of a detailed definition of the energy efficiency measures and referred costs and of the energy costs, according to the building end use for each country.

This work is funded by IEE Project RePublic_ZEB, Grant agreement no. IEE/13/886/SI2.674899

Thank you

laura.aelenei@lneg.pt