# Panorama da Reabilitação Energética em Portugal e na Europa

**Laura Aelenei, LNEG**

Jornadas de Conservação e Reabilitação

9 de Maio 2018

- Projecto (Nacional) SusCity
  - Soluções de reabilitação no âmbiente construído urbano – sector residencial
- Projeto (Europeu)  RePublic_ZEB
  - Soluções de reabilitação para edifícios publicos

# sumário

# PROJECTO/WP CONSÓRCIO










Massachusetts Institute of Technology







With the support of

# SusCity: Urban data driven models for creative and resourceful urban transitions


*Laura Aelenei*

**Objectivo**:

- Habilitar e demonstrar um conjunto de novos serviços que exploram oportunidades económicas associadas com a transição para sistemas urbanos sustentáveis.
- Caracterizar fluxos e stocks de recursos no sector residencial (escala do bairro)
    - Recolher e organizar informação
    - Desenvolver arquétipos de edifícios
- Modelar fluxos urbanos
- Desenvolver uma ferramenta 3D interativa para analisar, visualizar e comunicar os fluxos e stocks de recursos no sector residencial

SusCity

| | |
|---|---|
| WP 1 | Analítica urbana |
| WP 2 | Serviço de informação e plataforma de processamento de dados |
| WP 3 | Soluções para edifícios inteligentes |
| WP 4 | Soluções de mobilidade inovadoras |
| WP 5 | Serviços baseados em redes inteligentes |
| WP 6 | Laboratório de competividade urbana |



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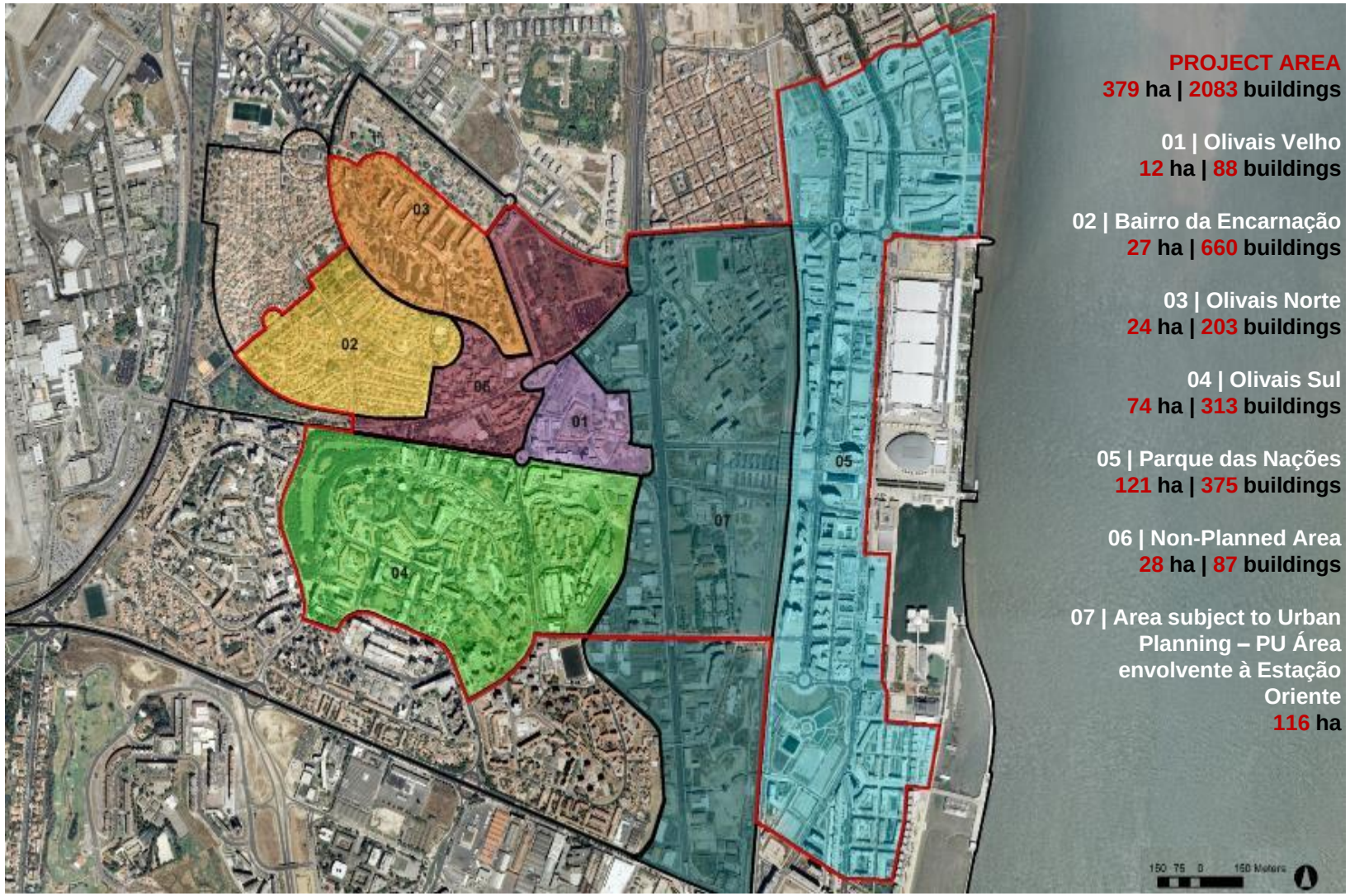
# ÁREA - TEST BED




**PROJECT AREA**
**379 ha | 2083 buildings**

**01 | Olivais Velho**
**12 ha | 88 buildings**

**02 | Bairro da Encarnação**
**27 ha | 660 buildings**

**03 | Olivais Norte**
**24 ha | 203 buildings**

**04 | Olivais Sul**
**74 ha | 313 buildings**

**05 | Parque das Nações**
**121 ha | 375 buildings**

**06 | Non-Planned Area**
**28 ha | 87 buildings**

**07 | Area subject to Urban Planning – PU Área envolvente à Estação Oriente**
**116 ha**

SusCity

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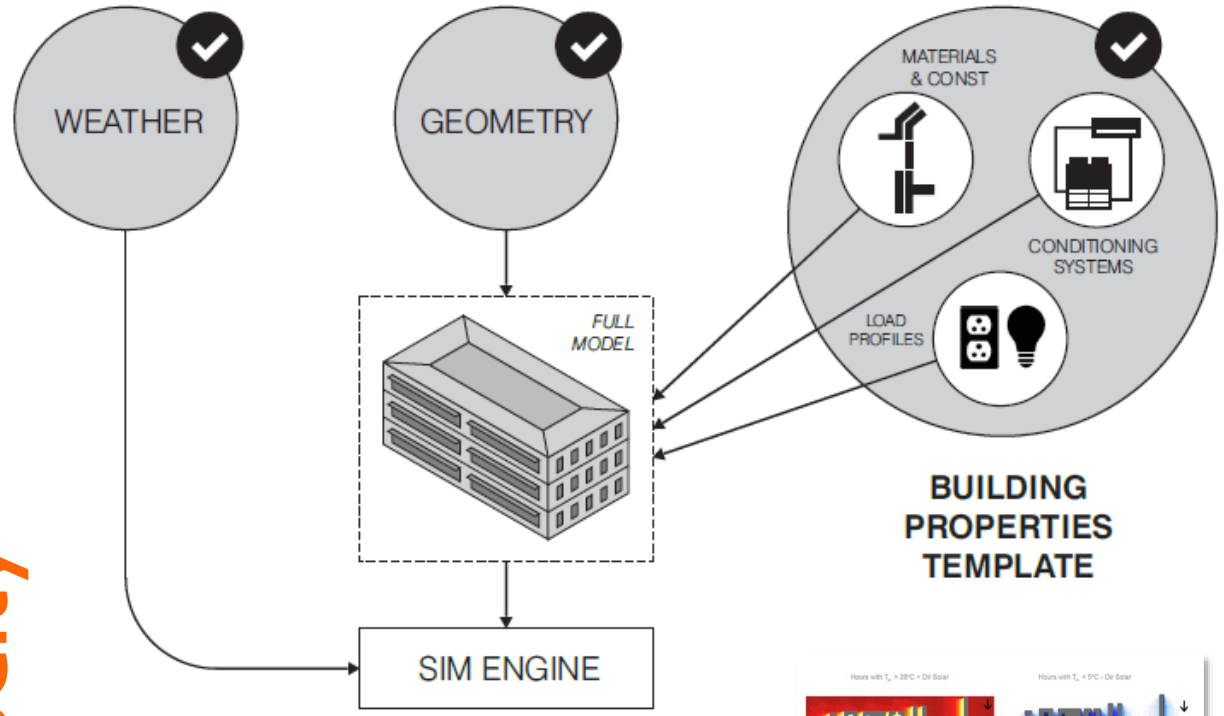
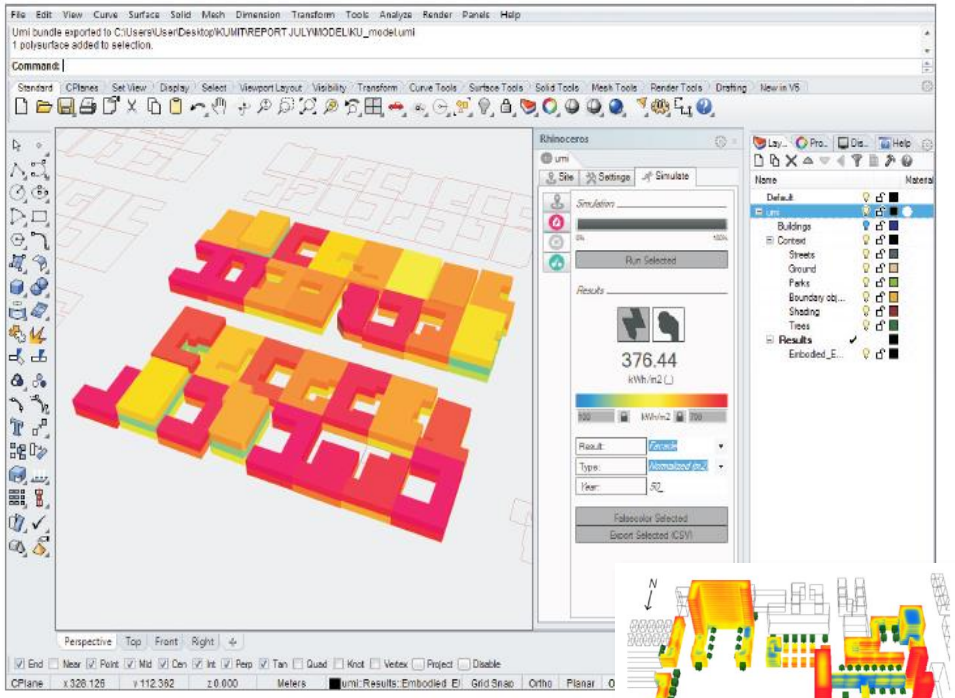
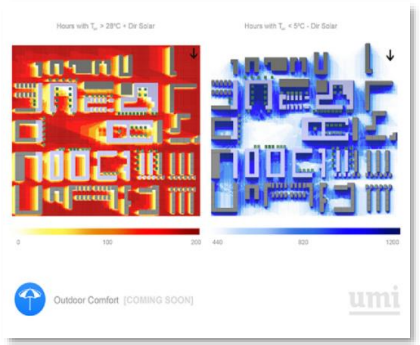
# Umi – Configuração do modelo




SusCity



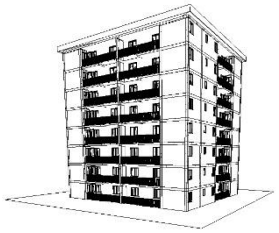
Urban Modeling Interface within Rhinoc



# ARQUÉTIPOS DE EDIFICIOS

2%
2125

R3_SF_C



8%
6912

R4_MF_I

29%
23850

R4_MF_C

36%
14700

R5_MF_C

10%
4352

R6_MF_C

**BIM**

Building Information Modeling

# SusCity - WP3 - Construção de soluções inteligentes

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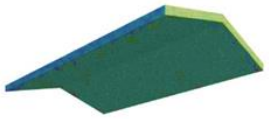
## MODEL INPUTS

| CATEGORY | FAMILY | Material | Thick (m) | R (m2.K/W) | k (W/mK) | $c_p$ (J/kg.K) | ρ (kg/m3) | Therm. ε | Solar α | Visual α |
|---|---|---|---|---|---|---|---|---|---|---|
| SuperStructure | Rectangular Footing | Concrete | 0,5 | 0,025 | 2 | 840-1040 | 2300-2400 | 0,92-0,97 | - | - |
| | Rectangular Beams | Concrete | 0,4 | 0,025 | 2 | 840-1041 | 2300-2401 | 0,92-0,98 | - | - |
| | Rectangular Columns | Concrete | 0,3 | 0,025 | 2 | 840-1042 | 2300-2402 | 0,92-0,99 | - | - |

| CATEGORY | FAMILY | Material | Thick (m) | R (m2.K/W) | k (W/mK) | $c_p$ (J/kg.K) | ρ (kg/m3) | Therm. ε | Solar α | Visual α |
|---|---|---|---|---|---|---|---|---|---|---|
| Floor | Interior Floor | Ceramic tiles | 0,02 | 0,015 | 1,3 | 745 | 2300 | | - | - |
| | | Reinforced Concrete slab | 0,05 | 0,025 | 2 | 840-1040 | 2300-2400 | 0,92-0,97 | - | - |
| | | Hollow Brick Blocks | 0,06 | 0,146 | 0,41 | 920-1000 | 1000-1200 | 0,93 | - | - |
| | | Finishing - plaster | 0,03 | 0,038 | 0,8 | | <1600 | 0,87 | - | - |
| | Ground Floor | Ceramic tiles | 0,02 | 0,015 | 1,3 | 745 | 2300 | | - | - |
| | | Reinforced Concrete Slab | 0,15 | 0,075 | 2 | 840-1040 | 2300-2400 | 0,92-0,97 | - | - |
| | | Damp-Proofing | 0,008 | 0,007 | 1,15 | 920 | <2100 | | - | - |
| | | Poor Concrete | 0,1 | 0,061 | 1,65 | 840-1040 | 2000-2300 | 0,92-0,97 | - | - |
| | | Gravel | 0,1 | 0,050 | 2 | - | 1700-2200 | | - | - |

| CATEGORY | FAMILY | Material | Thick (m) | R (m2.K/W) | k (W/mK) | $c_p$ (J/kg.K) | ρ (kg/m3) | Therm. ε | Solar α | Visual α |
|---|---|---|---|---|---|---|---|---|---|---|
| Walls | Exterior Walls | Finishing - cement coating | 0,02 | 0,025 | 0,8 | 1,046 | 1600 | 0,87 | 0,4 | - |
| | | Hollow Brick Wall | 0,15 | 0,366 | 0,41 | 920-1000 | 1000-1200 | 0,93 | - | - |
| | | Air Gap - cavity no insulation | 0,03 | 0,18 | 0,025 | 1000 | 1,23 | | | |
| | | Hollow Brick Wall | 0,11 | 0,268 | 0,41 | 920-1000 | 1000-1200 | 0,93 | - | - |
| | | Stucco | 0,02 | 0,025 | 0,8 | | <1600 | 0,87 | - | - |
| | Interior Walls | Stucco | 0,02 | 0,025 | 0,8 | | <1600 | 0,87 | - | - |
| | | Hollow Brick | 0,15 | 0,366 | 0,41 | 920-1000 | 1000-1200 | 0,93 | - | - |
| | | Stucco | 0,02 | 0,025 | 0,8 | | <1600 | 0,87 | - | - |



| CATEGORY | FAMILY | Material | Thick (m) | R (m2.K/W) | k (W/mK) | $c_p$ (J/kg.K) | ρ (kg/m3) | Therm. ε | Solar α | Visual α |
|---|---|---|---|---|---|---|---|---|---|---|
| Roof | Sloped Roof | Clay Ceramic Tiles | 0,03 | 0,018 | 1,65 | 840-1040 | 2000-2300 | 0,92-0,97 | | |
| | | Damp-Proofing | 0,008 | 0,007 | 1,15 | 920 | <2100 | | - | - |
| | | Poor Concrete | 0,04 | 0,024 | 1,65 | 840-1040 | 2000-2300 | 0,92-0,97 | - | - |
| | | Reinforced Concrete slab | 0,05 | 0,025 | 2 | 840-1040 | 2300-2400 | 0,92-0,97 | - | - |
| | | Hollow Brick Blocks | 0,06 | 0,146 | 0,41 | 920-1000 | 1000-1200 | 0,93 | - | - |
| | | Stucco | 0,03 | 0,038 | 0,8 | | <1600 | 0,87 | - | - |

| CATEGORY | FAMILY | Material | Frame Type | Solar Factor* | Glass Transmittance* | Color | Break(Y/N) | AreaRatio (%) | Operable (Y/N) |
|---|---|---|---|---|---|---|---|---|---|
| Window | Aluminium Window | Simple Glazing (4mm) | Aluminium Frame | 0,88 | 0,9 | no color | N | 30 | Y |

# SusCity - WP3 - Construção de soluções inteligentes

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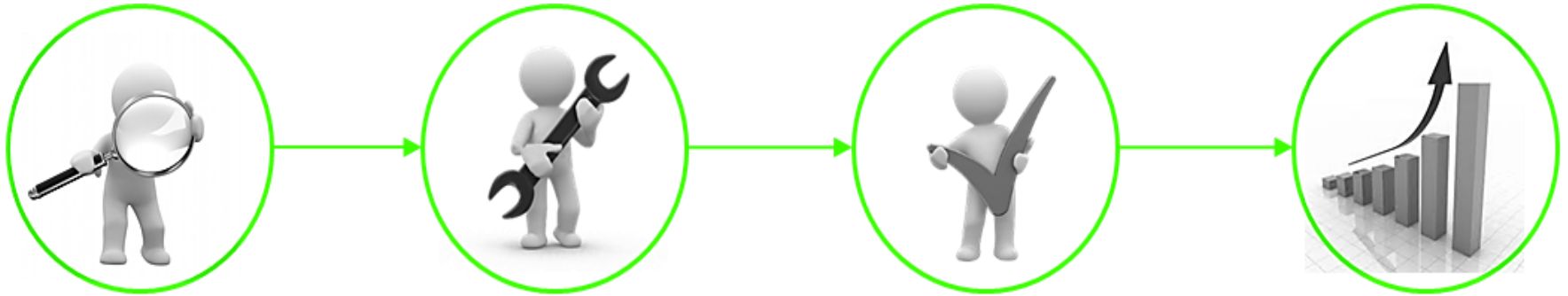



# SusCity - WP3 - Construção de soluções inteligentes

*Laura Aelenei*

# Monitorização de edifícios reais

R4_MF_SL_C
T3, Olivais Sul, 1971

R4_MF_SL_C
T2, Olivais Sul, 1967

R3_SF_SL_C
T2, Encarnação, 1947

R6_MF_FL_C
T3, Parque das Nações, 2006

R5_MF_FL_C
T4, Parque das Nações, 1996

R5_MF_FL_C
T4, Parque das Nações, 2000

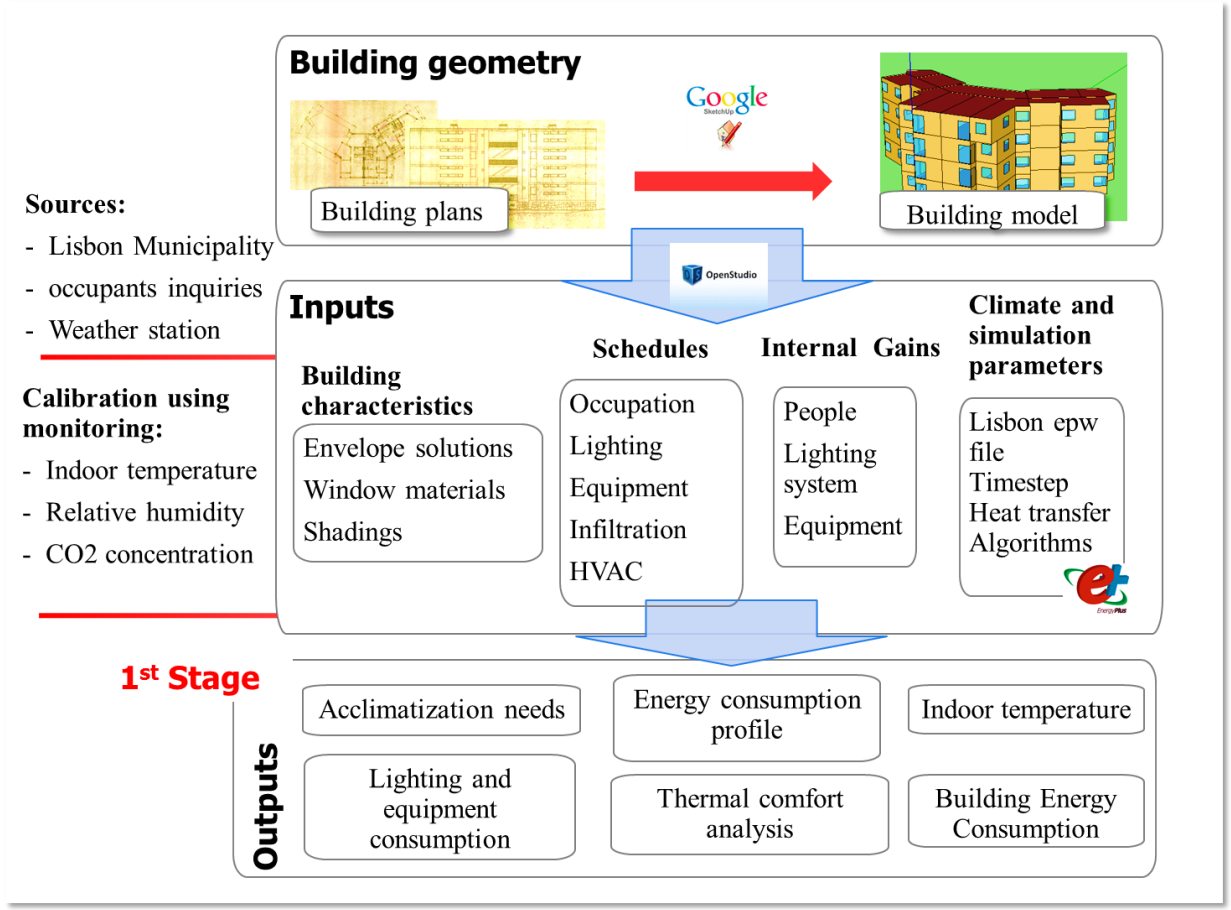
R5_MF_FL_C
T2, Parque das Nações, 2005

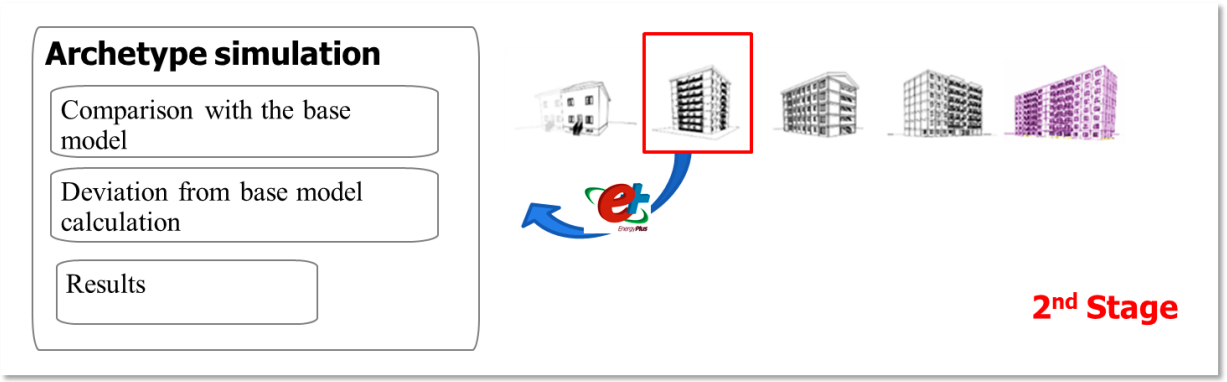
# Monitorização de edifícios reais

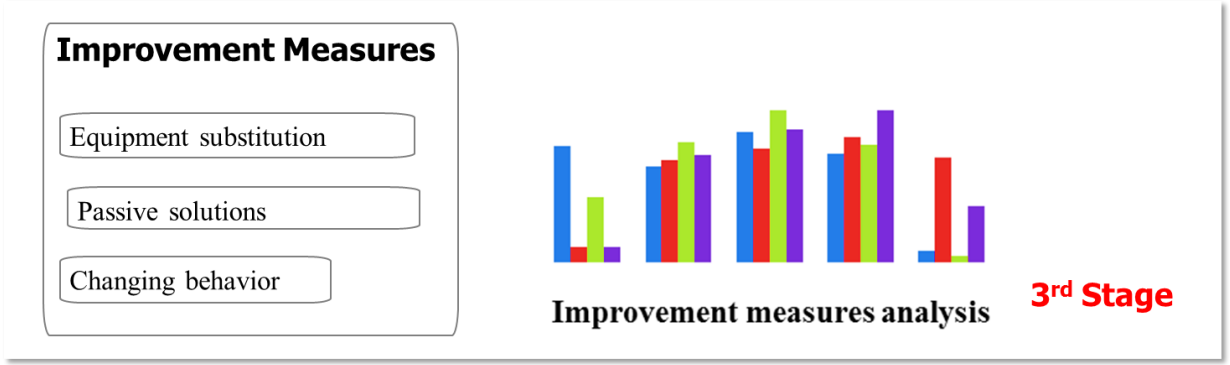
## Ferramentas de monitorização e dados de registro de equipamento

| Campanha de Monitorização | | | |
|---|---|---|---|
| Período de Monitorização | Parâmetros de Monitorização | Ferramentos/Equipamentos | |
| Sazonal:<br>Inverno/Verão<br><br>Diário | Comportamento Utilizadores | Inquéritos | |
| | Temperatura | Sensores | HOBO |
| | Humidade Relativa | | Testo |
| | $CO_2$/Rph | Sensores de Qualidade do Ar Interior Chauvin Arnoux | |
| | Consumo Eléctrico | Medidores de Corrente Chauvin Arnoux | |
| | Condições Exteriores: | | |
| | Temperatura | Sensores de Temperatura | |
| | Humidade Relativa | Sensores de Humidade | |
| | Radiação | Piranómetro | |
| | Velocidade do Vento<br>Direcção do Vento | Cata-Vento | |

# Calibração dos arquétipos com base no estudo de casos reais e dados de monitorização




# SusCity - WP3 - Construção de soluções inteligentes

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# SusCity - WP3 - Construção de soluções inteligentes

**MEDIDAS APLICADAS NA ENVOLVENTE**

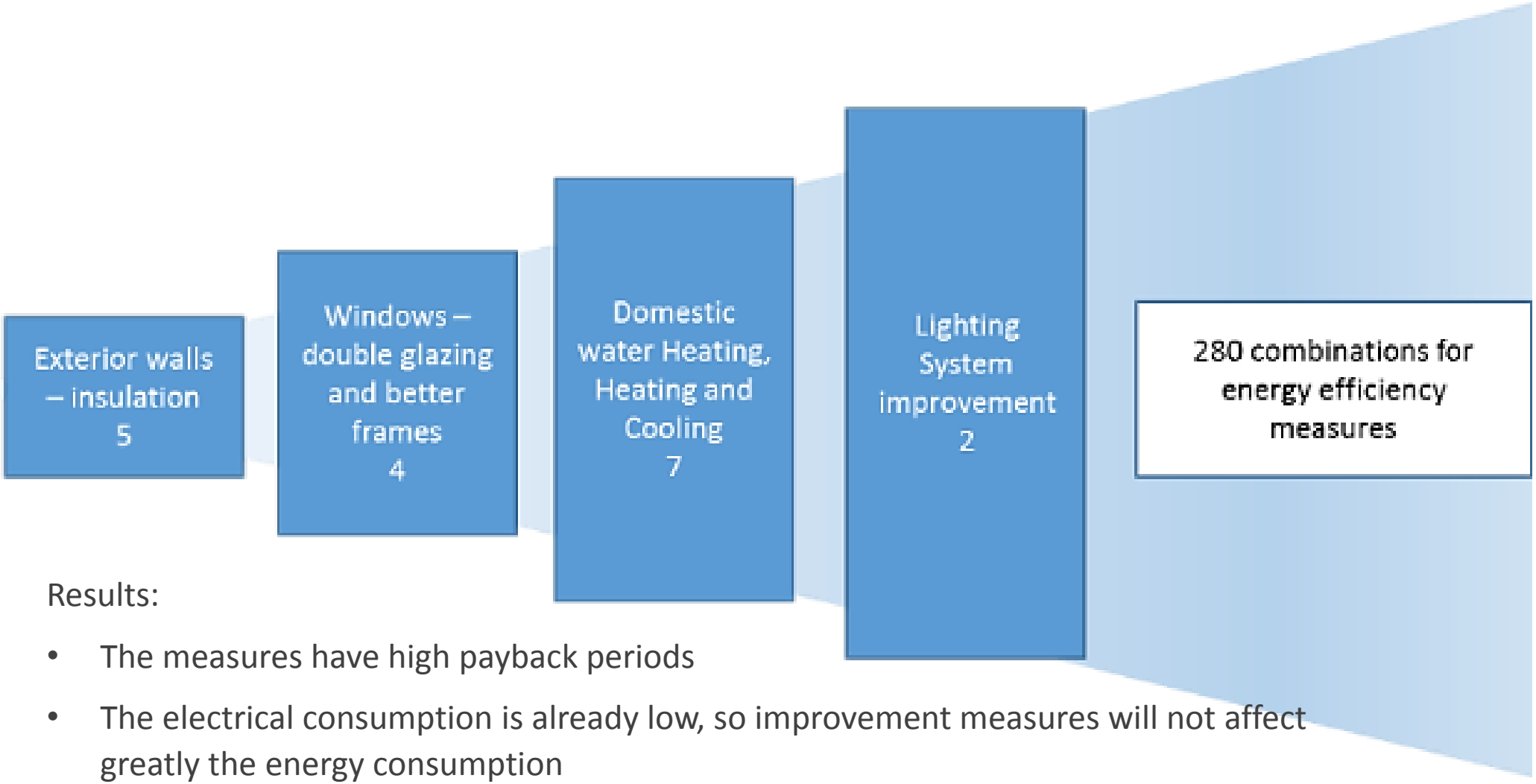
- Aplicação do isol
- Aplicação do isolamento térmico nas coberturas
- Aplicação do isolamento entre os pisos
- Substituição das janelas

**MEDIDAS APLICADAS AOS SISTEMAS**

- Aumento da eficiência energética da produção de sistemas AQS
- Aumento da eficiência dos sistemas de aquecimento e arrefecimento
- Utilização de energia solar para a produção de eletricidade e AQS
- Aumento de eficiência dos sistemas de iluminação
- Gestão inteligente de sistemas

# SusCity - WP3 - Construção de soluções inteligentes

## IDENTIFICATION OF ENERGY EFFICIENT TECHNIQUES - RESIDENTIAL




Results:

- The measures have high payback periods
- The electrical consumption is already low, so improvement measures will not affect greatly the energy consumption
- The measure with lower payback periods relies on the lighting replacement

# RePublic ZEB

## REfurbishment of the PUBLIC building stock towards nZEB

March 2014 – October 2016

## Coordination: CTI (Italian Thermotechnical Committee Energy and Environment)

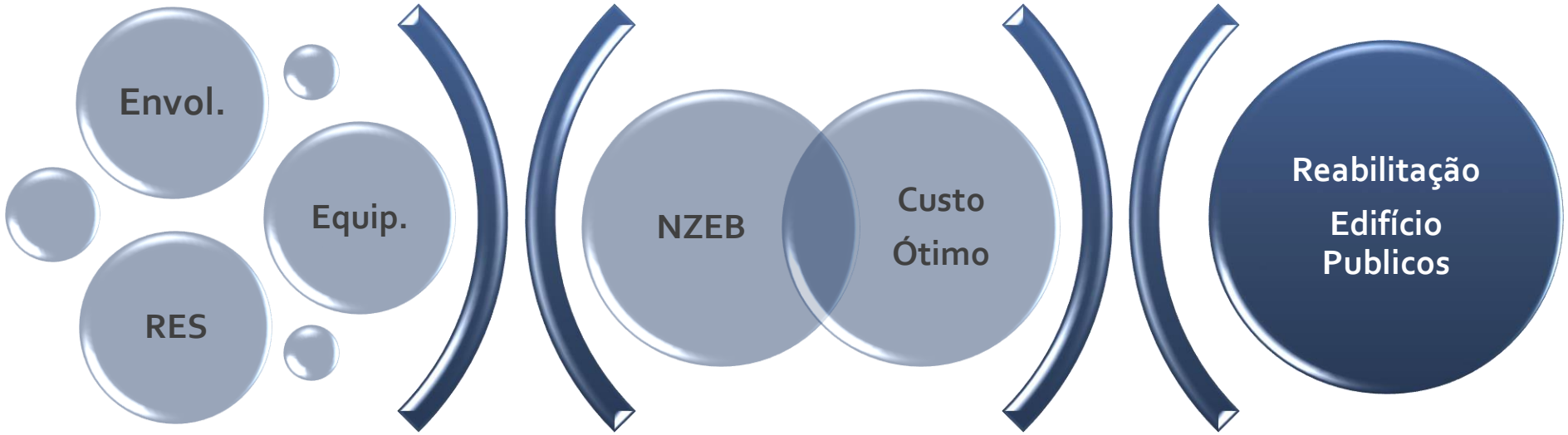
Partners

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

*Laura Aelenei*

RePublic_ZEB

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




Pacotes de medidas de EE

Metodologias

Alvo/Target



LNEG

DIRECTIVE 2010/31/EU OF THE EUROPEAN PARLIAMENT AND OF THE CONCIL
of 19 May 2010
on the energy performance of buildings
(recast)

EPBD Recast

THE EUROPEAN PARLIAMENT AND THE COUNCIL OF THE EUROPEAN UNION,

Having regard to the Treaty on the Functioning of the European Union, and in particular Article 194(2) thereof,

Having regard to the proposal from the European Commission,

Having regard to the opinion of the European Economic and Social Committee (1),

Having regard to the opinion of the Committee of the Regions (2),

Acting in accordance with the ordinary legislative procedure (3),

Whereas:

(1) Directive 2002/91/EC of the European Parliament and of the Council of 16 December 2002 on the energy performance of buildings (4) has been amended (5). Since further substantive amendments are to be made, it should be recast in the interests of clarity.

(2) An efficient, prudent, rational and sustainable utilisation of energy applies, inter alia, to oil products, natural gas and solid fuels, which are essential sources of energy, but also the leading sources of carbon dioxide emissions.

(3) Buildings account for 40 % of total energy consumption in the Union. The sector is expanding, which is bound to increase its energy consumption. Therefore, reduction of energy consumption and the use of energy from renewable sources in the buildings sector constitute important measures needed to reduce the Union's energy dependency and greenhouse gas emissions.

(1) OJ C 277, 17.11.2005, p. 75.
(2) OJ C 200, 25.8.2005, p. 41.
(3) Position of the European Parliament of 23 April 2009 (not yet published in the Official Journal), position of the Council at first reading of 14 April 2010 (not yet published in the Official Journal), position of the European Parliament of 18 May 2010 (not yet published in the Official Journal).
(4) OJ L 1, 4.1.2003, p. 65.

Together with an increased use of energy from renewable sources, measures to reduce energy consumption in the Union would allow the Union to comply with the Kyoto Protocol to the United Nations Framework Convention on Climate Change (UNFCCC), and to honour both its long term commitment to maintain the global temperature rise below 2 °C, and its commitment to reduce, by 2020, overall greenhouse gas emissions by at least 20 % below 1990 levels, and by 30 % in the event of an international agreement being reached. Reduced energy consumption and an increased use of energy from renewable sources also have an important part to play in promoting security of energy supply, technological development and in creating opportunities for employment and regional development, in particular in rural areas.

(4) Management of energy demand is an important tool enabling the Union to influence the global energy market and hence the security of energy supply in the medium and long term.

(5) The European Council of March 2007 emphasised the need to increase energy efficiency in the Union so as to achieve the objective of reducing by 20 % the Union's energy consumption by 2020 and called for a thorough and rapid implementation of the priorities established in the Commission Communication entitled 'Action plan for energy efficiency: realising the potential'. That action plan identified the significant potential for cost-effective energy savings in the buildings sector. The European Parliament, in its resolution of 31 January 2008, called for the strengthening of the provisions of Directive 2002/91/EC, and has called at various times, on the latest occasion in its resolution of 7 February 2009 on the Second Strategic Energy Review, for the 20 % energy efficiency target in 2020 to be made binding. Moreover, Decision No 406/2009/EC of the European Parliament and of the Council of 23 April 2009 on the effort of Member States to reduce their greenhouse gas emissions to meet the Community's greenhouse gas emission reduction commitments up to 2020 (6), sets national binding targets for $CO_2$ reduction for which energy efficiency in the building sector will be crucial, and Directive 2009/28/EC of the European Parliament and of the Council of 23 April 2009 on the promotion of the use of energy from renewable sources (7) provides for the promotion of energy efficiency in the context of a binding target for energy from renewable sources accounting for 20 % of total Union energy consumption by 2020.

(6) OJ L 140, 5.6.2009, p. 136.

## Artigo 9º
## Edifícios com necessidades quase nulas de energia

- O mais tardar em 31 de Dezembro de 2020, todos os edifícios novos sejam edifícios com necessidades quase nulas de energia; e;
- Após 31 de Dezembro de 2018, *os edifícios novos ocupados e detidos por autoridades públicas sejam edifícios com necessidades quase nulas de energia.*
- Elaborar planos nacionais para aumentar o número de edifícios nZEB seguindo o exemplo do sector público,
  - Objectivos intermédios para melhorar o desempenho energético dos edifícios novos, até 2015,
  - Descrição pormenorizada da definição nZEB/NZEB (incluíndo a renovação dos edifícios em direção a NZEB)



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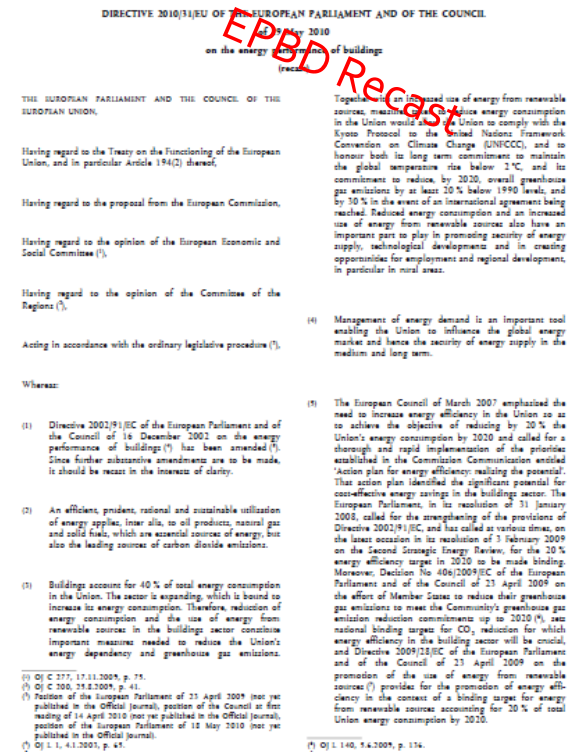

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(4) OJ L 1, 4.1.2003, p. 65.
(5) OJ L 140, 5.6.2009, p. 174.

*Artigo 5º*

## Cálculo dos níveis óptimos de rentabilidade dos requisitos mínimos de desempenho energético

- A Comissão estabelece uma metodologia comparativa para o cálculo dos níveis óptimos de rentabilidade dos requisitos mínimos de desempenho energético dos edifícios e dos componentes de edifícios.

- Os Estados-Membros devem calcular os níveis óptimos de rentabilidade dos requisitos mínimos de desempenho energético e parâmetros relevantes, como as condições climáticas e comparar os resultados deste cálculo com os requisitos mínimos de desempenho energético em vigor.

# REQUISITOS PARA A METODOLOGIA

- definir e selecionar edifícios representativos de cada tipologia e região do país, incluir as condições de clima interior e exterior, geometrias etc. - "edifícios de referência";
- estimar a energia fornecida e a energia primária para o edifícios de referência selecionado;
- determinar o ciclo de vida económico para o edifício de referência - custos de investimento, energia, mão de obra, manutenção e de eliminação para várias medidas de eficiência energética, e de fontes de energia renováveis (pacotes)
- traçar a curva de custo(s) e determinar o nível ótimo

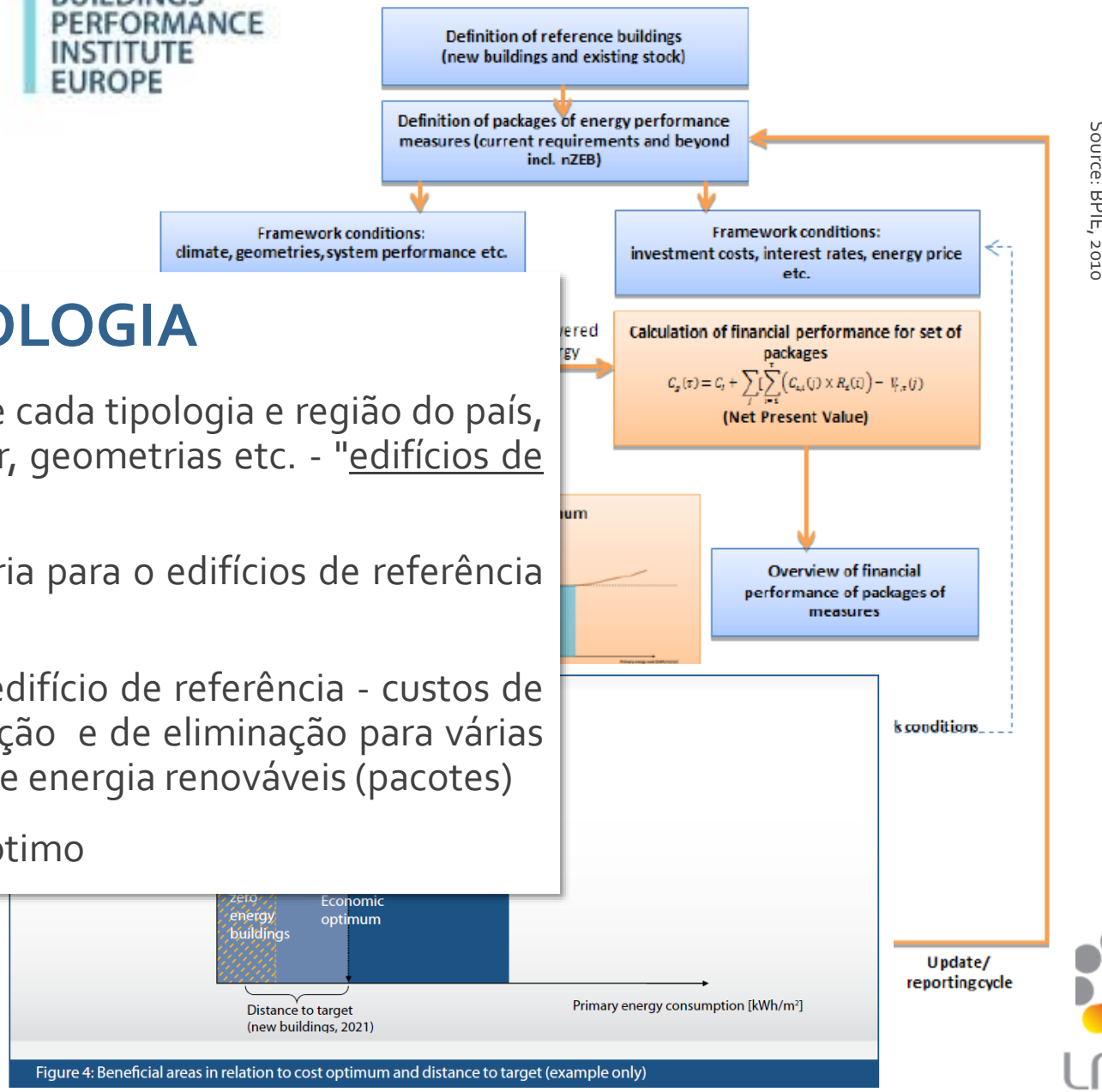


Figure 4: Beneficial areas in relation to cost optimum and distance to target (example only)

Source: BPIE, 2010

# RePublic_ZEB- 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)

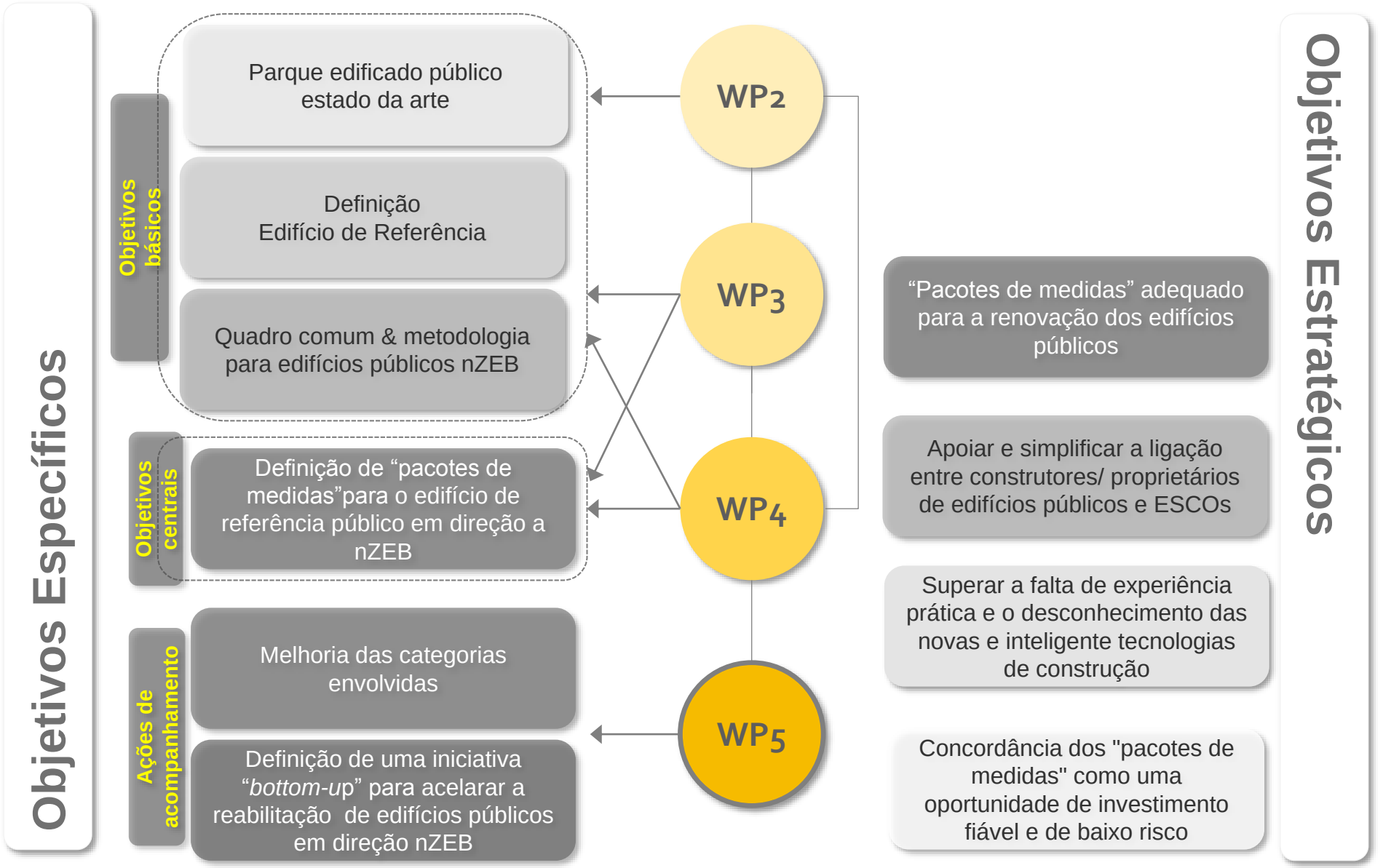
WP5 Strategies and guidelines towards nZEBs
(Lead: LNEG)

WP6 Communication and dissemination
(Lead: BRE)



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

# Objetivos




*Laura Aelenei e Ana Ferreira*

# WP2 – Classificação do parque edificado público

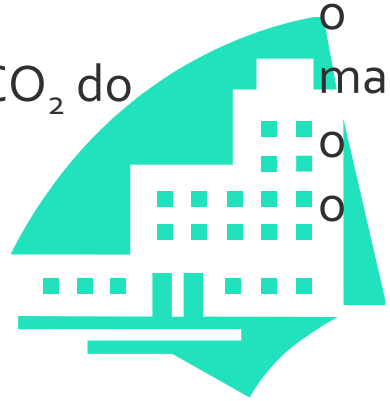

*Laura Aelenei e Ana Ferreira*

# WP2 – Análise do parque edificado público - Método de seleção

## Selecção das Categorias de Edifícios

### Os seguintes critérios foram aplicados para a escolha de categorias representativas:

- Área condicionada do edifício, $m^2$;
- Energia especifica final e primária consumida, $kWh/m^2.ano$;
- Quantidade de equivalente de emissão de $CO_2$ do consumo específico de energia, $kg/m^2.ano$.



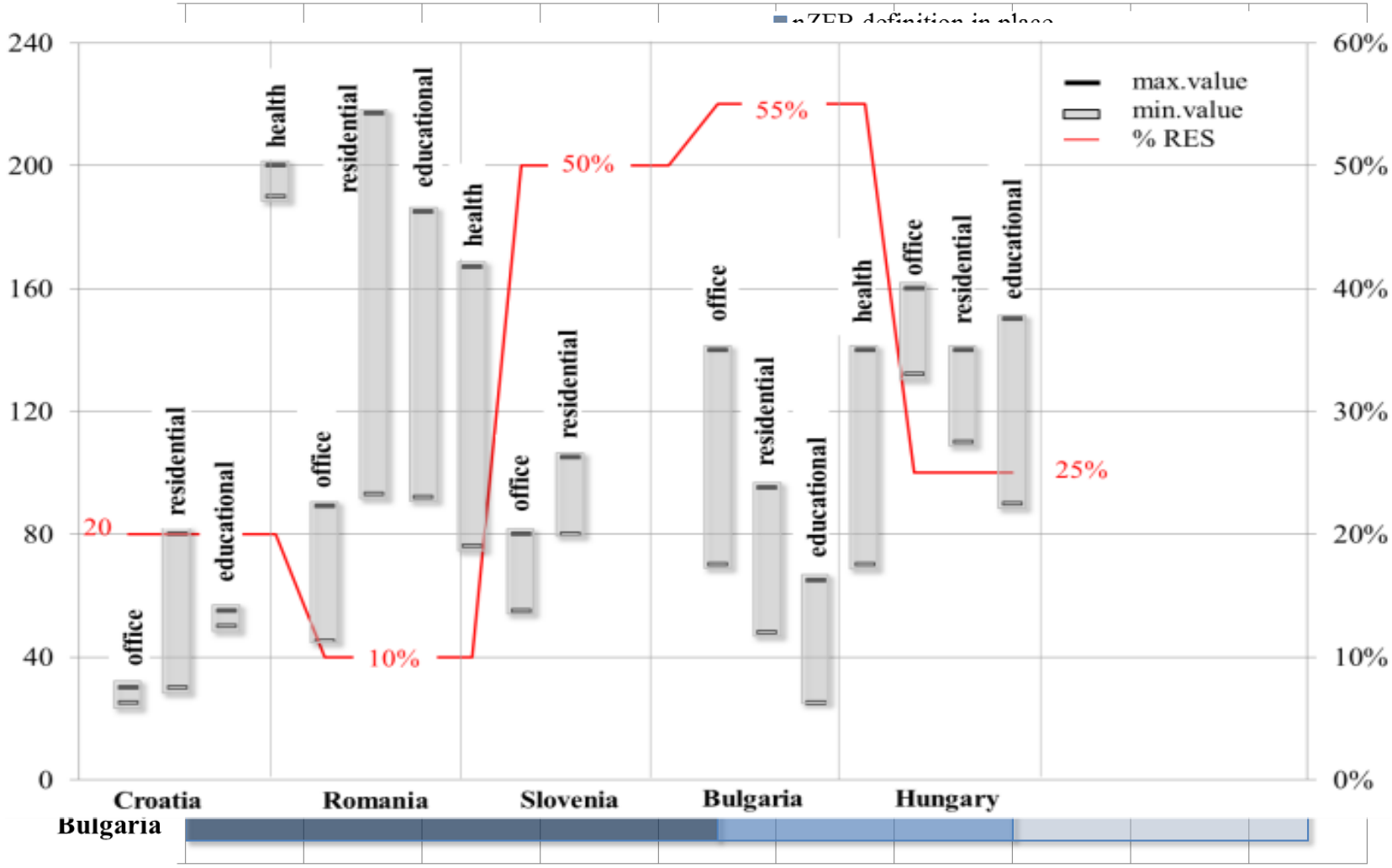
## Seleção dos Edifícios de Referência

### Os seguintes critérios foram aplicados:

- Área total e condicionada de pavimento;
- Idade do edifício;
- Materiais de construção e correspondente propriedades térmicas da envolvente do edifício;
- Horários de utilização;
- Sistemas técnicos/instalações para a manutenção do ambiente construído;
- Padrões operacionais;
- Tipos de energia utilizadas para aquecimento.

*Laura Aelenei e Ana Ferreira*

# WP3 – Avaliação do status quo e análise de oportunidades para a reabilitação de edifícios públicos em direcão NZEB




*Laura Aelenei e Ana Ferreira*

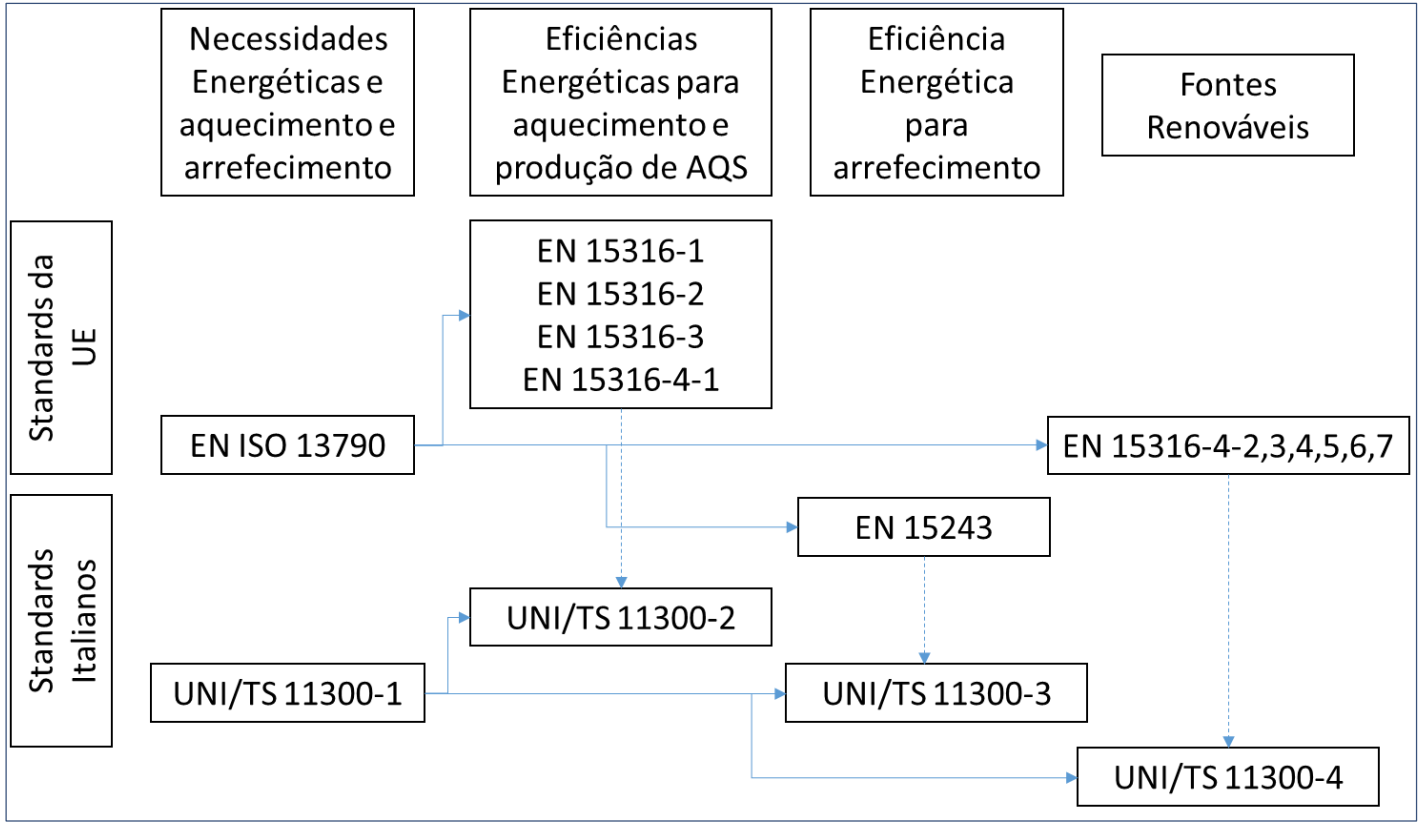
# WP4 – Modelação dos edifícios – Folha de Cálculo ***POLITO***

**Permite avaliar:**

- As necessidade energéticas para:
  - Aquecimento/Arrefecimento;
  - Produção de AQS;
  - Ventilação;
  - Iluminação.
- A demanda de energia para cada tipo de energia de cada necessidade energética;
- O valor de cada componente de energia primária:
  - Não-renovável;
  - Renovável;
  - Total.
- O índice de energia renovável, RER;

A ferramenta leva em conta a transposição italiana das normas da UE.

Método de cálculo quási-estável, baseado nas condições mensais.




**Sistemas técnicos** para aquecimento, arrefecimento e produção de AQS subdivididos em subsistemas: emissão, controlo, distribuição, armazenamento (se possível) e geração).

*Laura Aelenei e Ana Ferreira*

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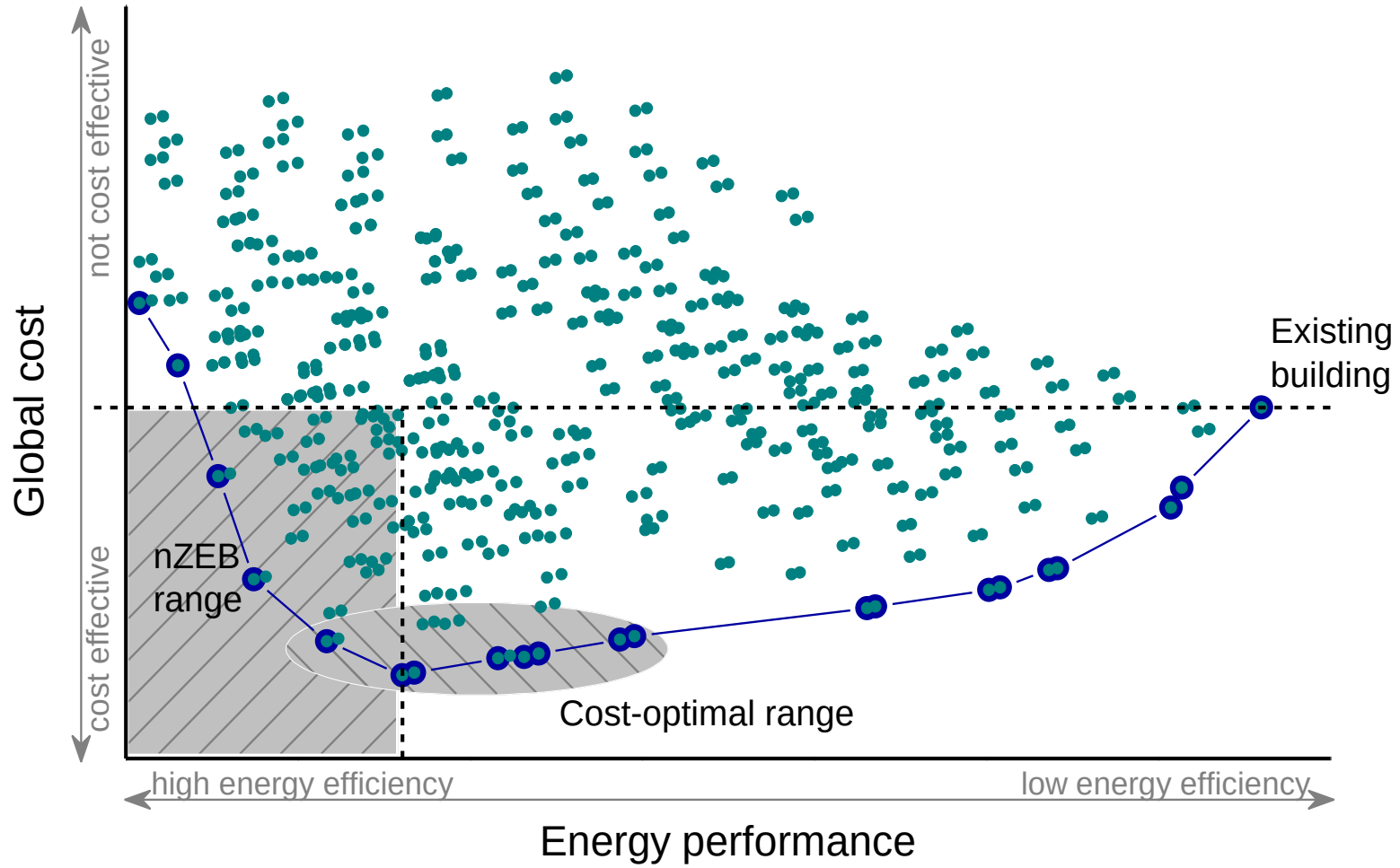
# Common criteria and principles for public building nZEB definition in south and east European countries

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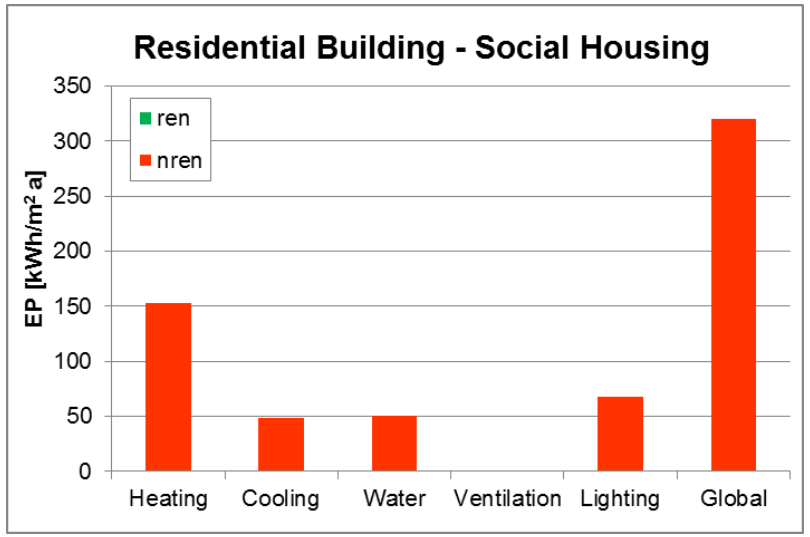
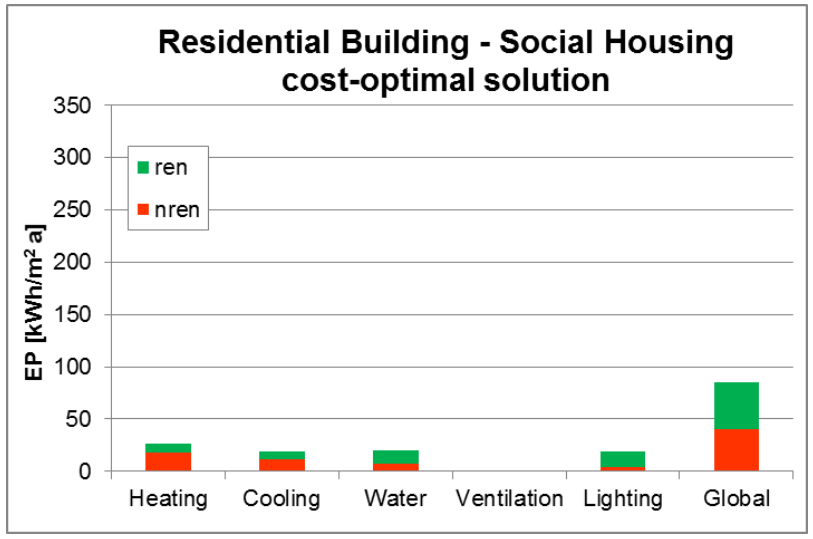
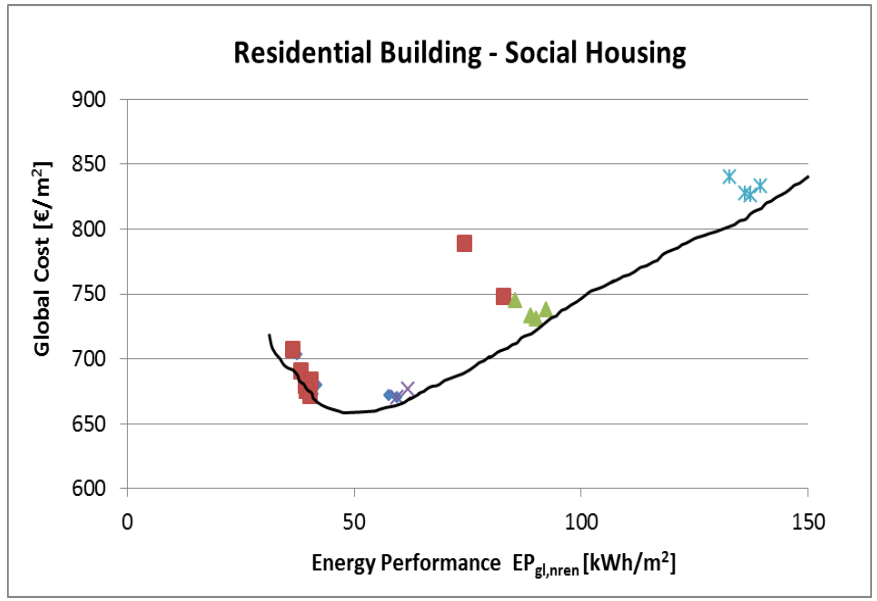
# WP4 – Resultados modelação: *Residencial*

Edifício de Referência




Edifício de Referência com a Solução Ótima




| N.º | Medida de Eficiência Energética (MEE) | Simbolo | Edifício de Referência | Edificio Solução Ótima | |
|---|---|---|---|---|---|
| | | | Valor | Valor | N.º MEE |
| 1 | Isolamento térmico pelo exterior, Paredes | $U_p$ | 1,76 | **0,4** | 2 |
| 3 | Isolamento térmico, Cobertura | $U_r$ | 2,8 | **0,4** | 1 |
| 4 | Isolamento térmico, Pavimento | $U_f$ | 2,1 | **0,7** | 1 |
| 5 | Vão envidraçado com U melhorado | $U_w$ | 5,2 | **2,8** | 1 |
| 6 | Sombreamento solar | $\tau_s$ | | **1** | 1 |
| 10 | Sistema combinado de produção de AQS e aquecimento | COP | | **1,1** | 2 |
| 12 | Paineis solar térmicos | $m^2$ | | **32** | 1 |
| 13 | Sistema fotovoltaico | $kW_p$ | | **4** | 1 |
| 16 | Densidade de potência de iluminação | PN | 9 | **1,28** | 2 |

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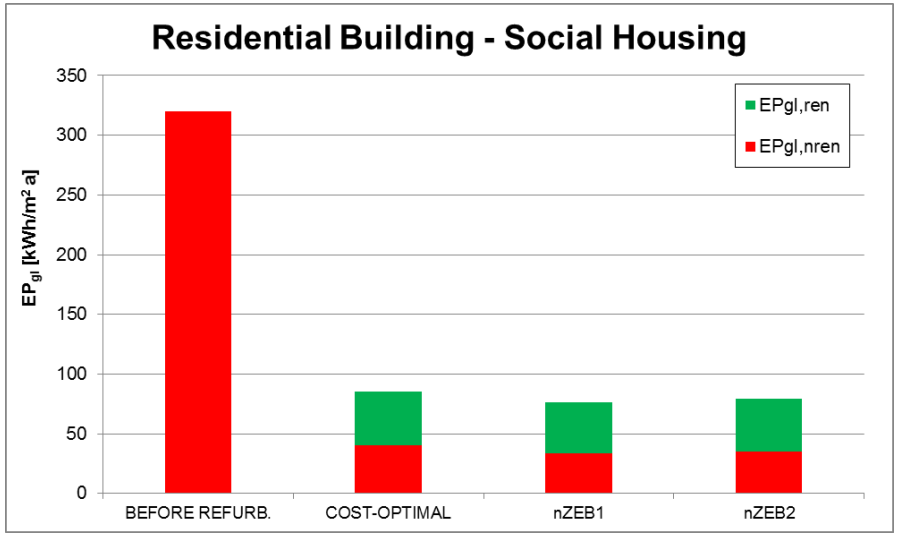
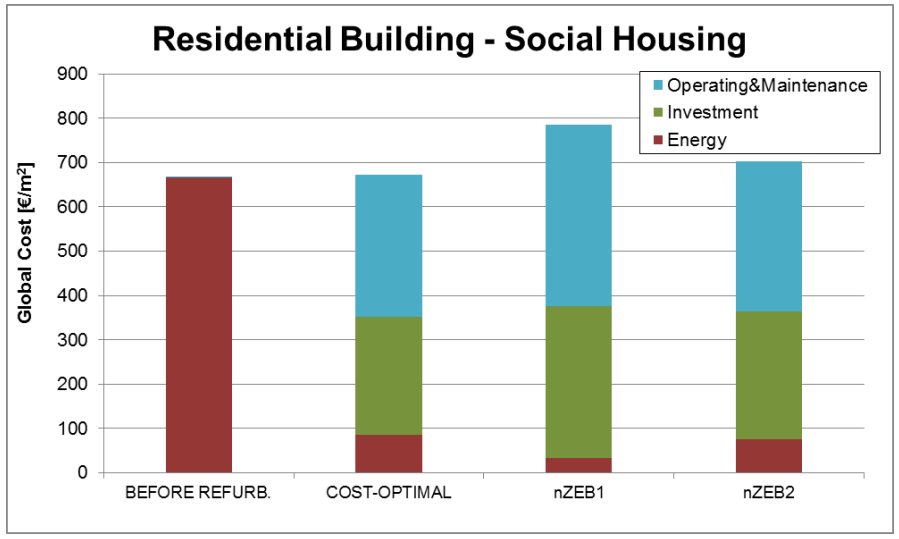
# WP4 – Resultados modelação: *Residencial*

Desempenho Energético




Custo Global




| N.º | Medida de Eficiência Energética (MEE) | Simbolo | Edifício de Referência | nZEB_1 | |
|---|---|---|---|---|---|
| | | | Valor | Valor | Tecnologia |
| 1 | Isolamento térmico pelo exterior, Paredes | $U_p$ | 1,76 | **0,2** | 12 cm EPS |
| 3 | Isolamento térmico, Cobertura | $U_r$ | 2,8 | **0,3** | 10 cm EPS |
| 4 | Isolamento térmico, Pavimento | $U_f$ | 2,1 | **0,4** | 10 cm EPS |
| 5 | Vão envidraçado com U melhorado | $U_w$ | 5,1 | **2,1** | Vidro duplo, caixilho com corte térmico |
| 6 | Sombreamento solar | – | | **int** | Sombreamento pelo interior |
| 10 | Sistema combinado de produção de AQS e aquecimento | COP | | **0,83** | Caldeira a biomassa |
| 12 | Painéis solar térmicos | $m^2$ | | **32** | Plano |
| 13 | Sistema Fotovoltaico | $kW_p$ | | **4** | Monocristalino |
| 16 | Sistema de Iluminação | PN | 10 | **1,28** | LED |

| N.º | Medida de Eficiência Energética (MEE) | Simbolo | Edifício de Referência | nZEB_2 | |
|---|---|---|---|---|---|
| | | | Valor | Valor | Tecnologia |
| 1 | Isolamento térmico pelo exterior, Paredes | $U_p$ | 1,76 | **0,2** | 12 cm EPS |
| 3 | Isolamento térmico, Cobertura | $U_r$ | 2,8 | **0,3** | 10 cm EPS |
| 4 | Isolamento térmico, Pavimento | $U_f$ | 2,1 | **0,4** | 10 cm EPS |
| 5 | Vão envidraçado com U melhorado | $U_w$ | 5,1 | **2,1** | Vidro duplo, caixilho com corte térmico |
| 6 | Sombreamento solar | – | | **int** | Sombreamento pelo interior |
| 10 | Sistema combinado de produção de AQS e aquecimento | COP | | **1,1** | Caldeira a gás natural |
| 12 | Painéis solar térmicos | $m^2$ | | **32** | Plano |
| 13 | Sistema Fotovoltaico | $kW_p$ | | **4** | Monocristalino |
| 16 | Sistema de Iluminação | PN | 10 | **1,28** | LED |

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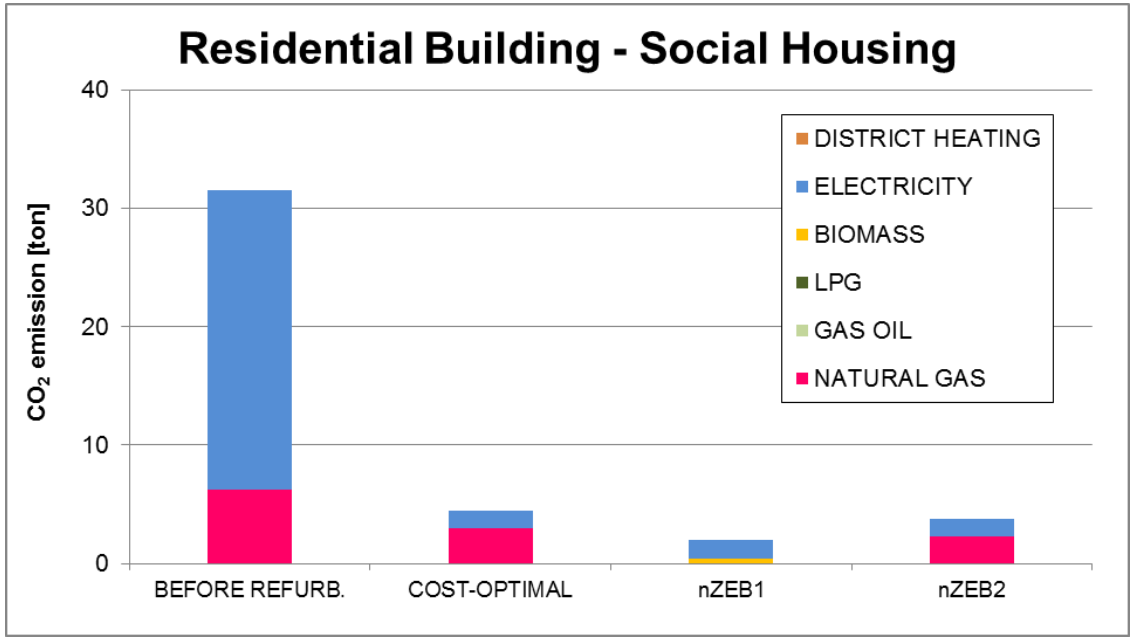
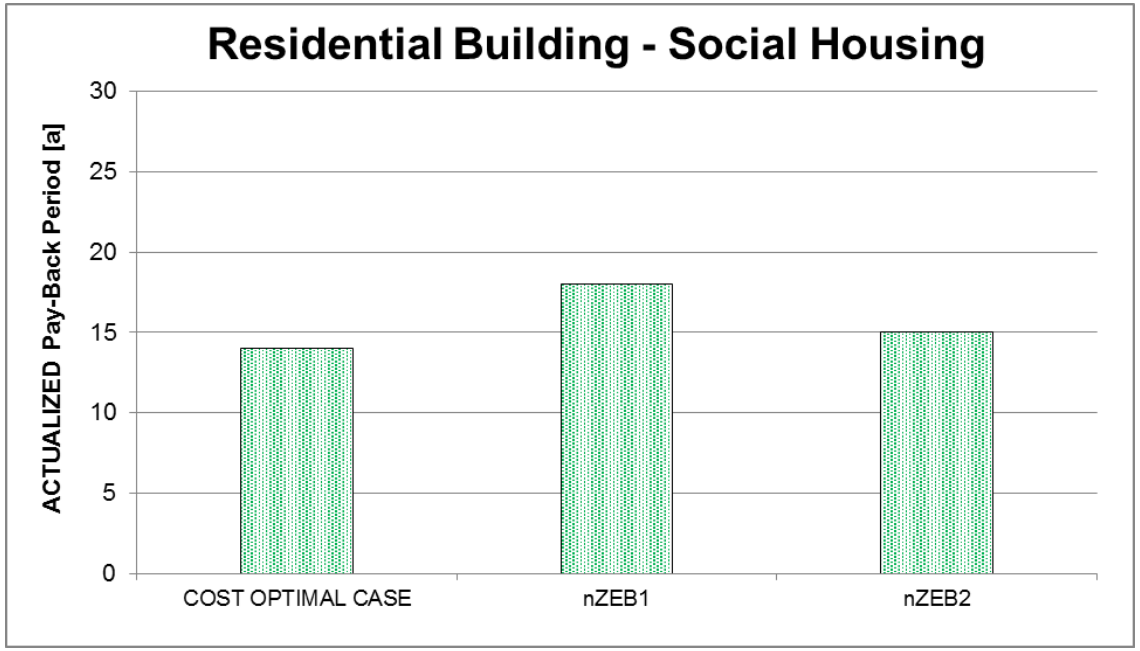
# WP4 – Resultados modelação: *Residencial*




**Emissões de $CO_2$**

**Período de Retorno**

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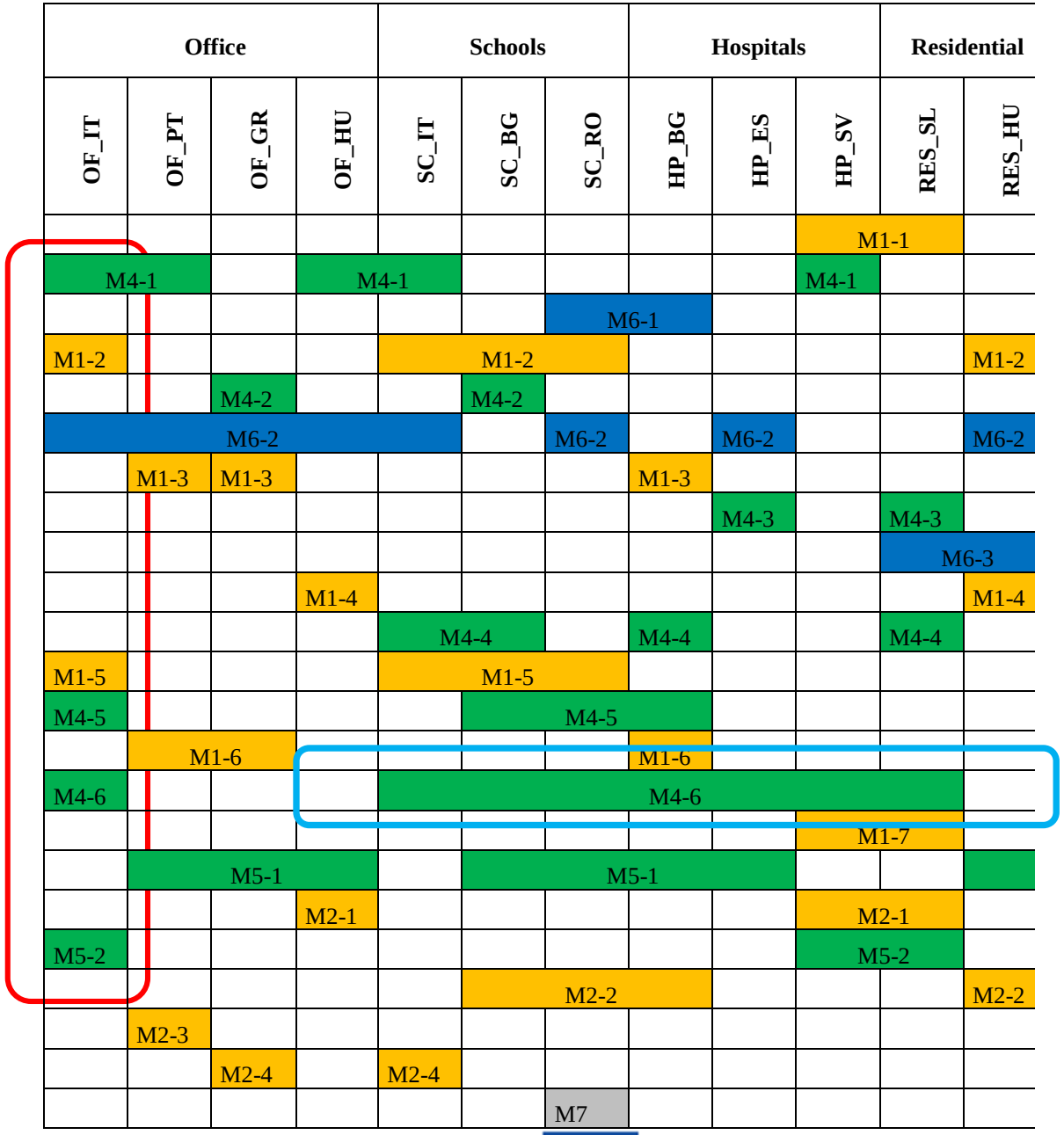
# Matrix

Envelope solutions
Energy Efficient systems solutions
Renewable energy Systems solutions

| | | |
|---|---|---|
| M1 Wall insulation | M1-1 | Roof – External insulation (25-34 cm EPS) |
| | M1-2 | Roof – External insulation (15-22 cm XPS) |
| | M1-3 | Roof – External insulation (6-10 cm XPS) |
| | M1-4 | Wall – External insulation (20 -22 cm EPS) |
| | M1-5 | Wall – External insulation (12-15 cm EPS) |
| | M1-6 | Wall – External insulation (3-9 cm EPS) |
| | M1-7 | Wall – External insulation (30cm EPS) |
| M2 Windows | M2-1 | Window – Triple glass low-e filled with gas |
| | M2-2 | Window in PVC – Triple glass low-e |
| | M2-3 | Window in PVC – Double glass |
| | M2-4 | Window in aluminum – Double glass, low-e |
| M3 shading | M3-1 | External movable shadings |
| | M3-2 | External fixed shadings |
| M4 Energy Efficient Systems | M4-1 | Air source heat pump |
| | M4-2 | Ground or water source heat pump |
| | M4-3 | High efficient chiller |
| | M4-4 | Mechanical ventilation |
| | M4-5 | Heat recovery system |
| | M4-6 | Load management |
| M5 Lighting | M5-1 | LED |
| | M5-2 | Linear fluorescent lamp T5, T8 |
| M6 RES | M6-1 | Solar Thermal systems |
| | M6-2 | Photovoltaic system (monocrystalline, polycrystalline) |
| | M6-3 | Biomass boiler |
| M7 | M7 | District heating |

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# RePublic_ZEB- webpage

http://www.republiczeb.org/




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## obrigada

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