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Definition of nearly zero energy building and cost-optimal energy performance in 2020

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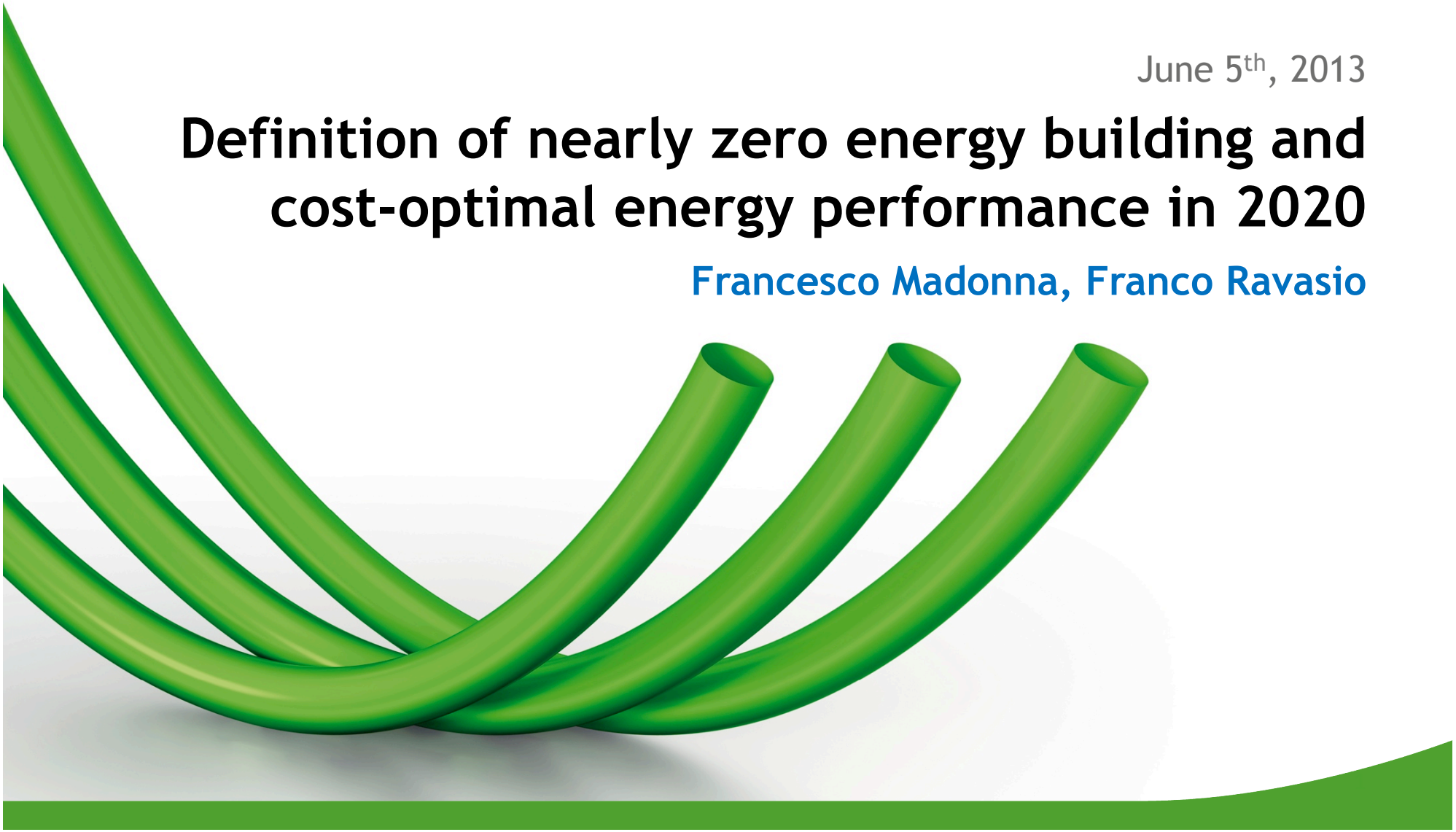
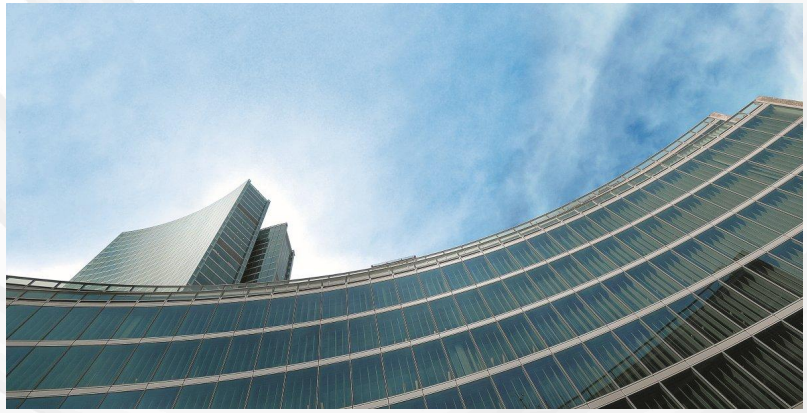


Nearly zero energy building

Directive 2010/31/EU defines NZEB as "*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 definition is qualitative: each Member State has to quantitatively specify which requirements a buildings has to fulfill in order to be classified as a NZEB.



Cost-optimal levels

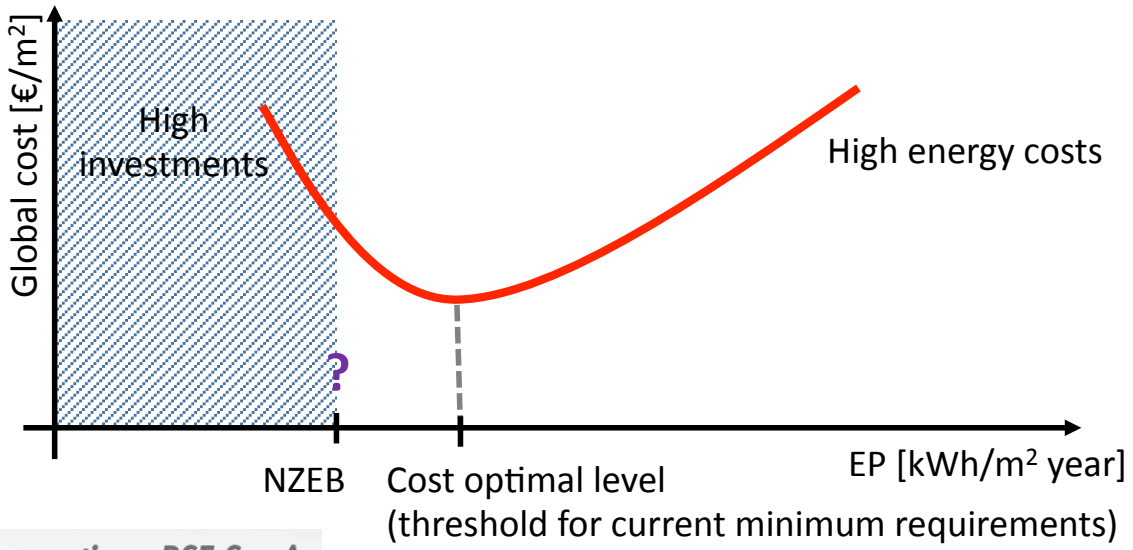
Cost-optimal level means the energy performance level which leads to the lowest cost during the estimated economic lifecycle.

Minimum requirements for the energy performance of buildings and building elements should be set with a view to achieving the **cost-optimal balance between the investments involved and the energy costs saved throughout the lifecycle of the building**.

Member States can set minimum requirements which are more energy efficient than cost-optimal energy efficiency levels.

Cost-optimal levels shall be calculated in accordance with the comparative methodology framework (Commission delegated regulation No 244/2012).

Application of the comparative methodology framework



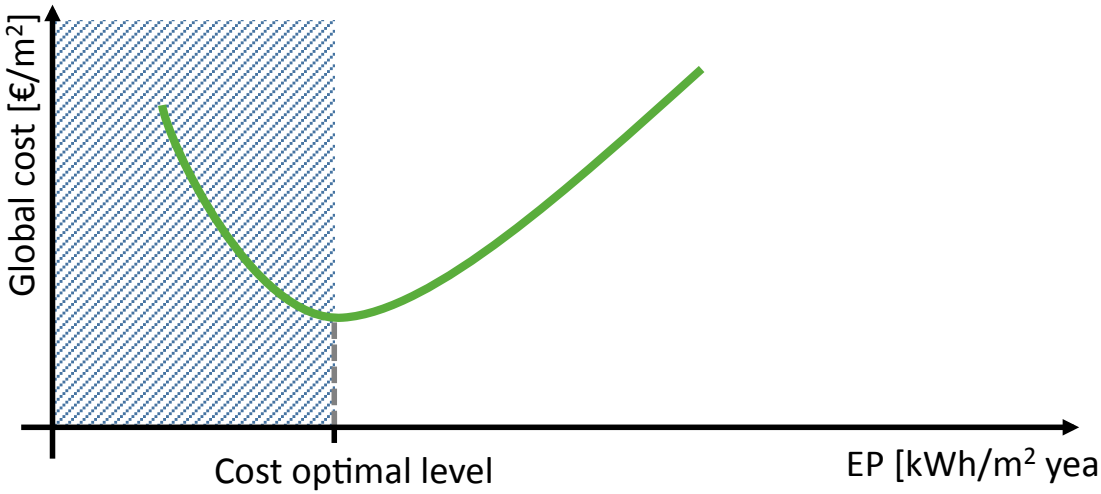
Link between NZEB and cost-optimal levels

All new buildings must be NZEB by the end of 2020.

In other words:
NZEB performance will be the minimum energy performance requirement for new buildings by the end of 2020.

NZEB energy performance will have to be equal or better than the cost-optimal level in 2020.

Application of the comparative methodology framework in 2020

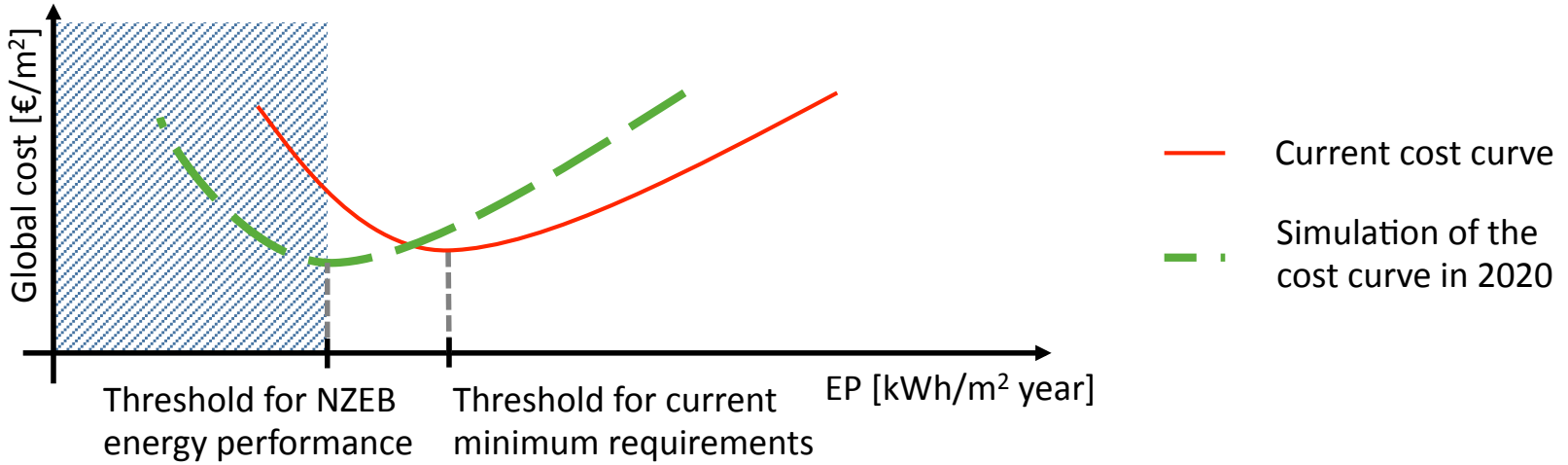


(threshold for 2020 minimum requirements, i.e. NZEB energy performance)

Member States are required to review minimum energy performance requirements and the application of comparative methodology framework at regulars intervals.

NZEB as cost-optimal level in 2020

We propose **a simulation** of the application of the comparative methodology framework in 2020.



To perform the simulation we define a scenario to take into account how the main parameters will change, particularly we assume:

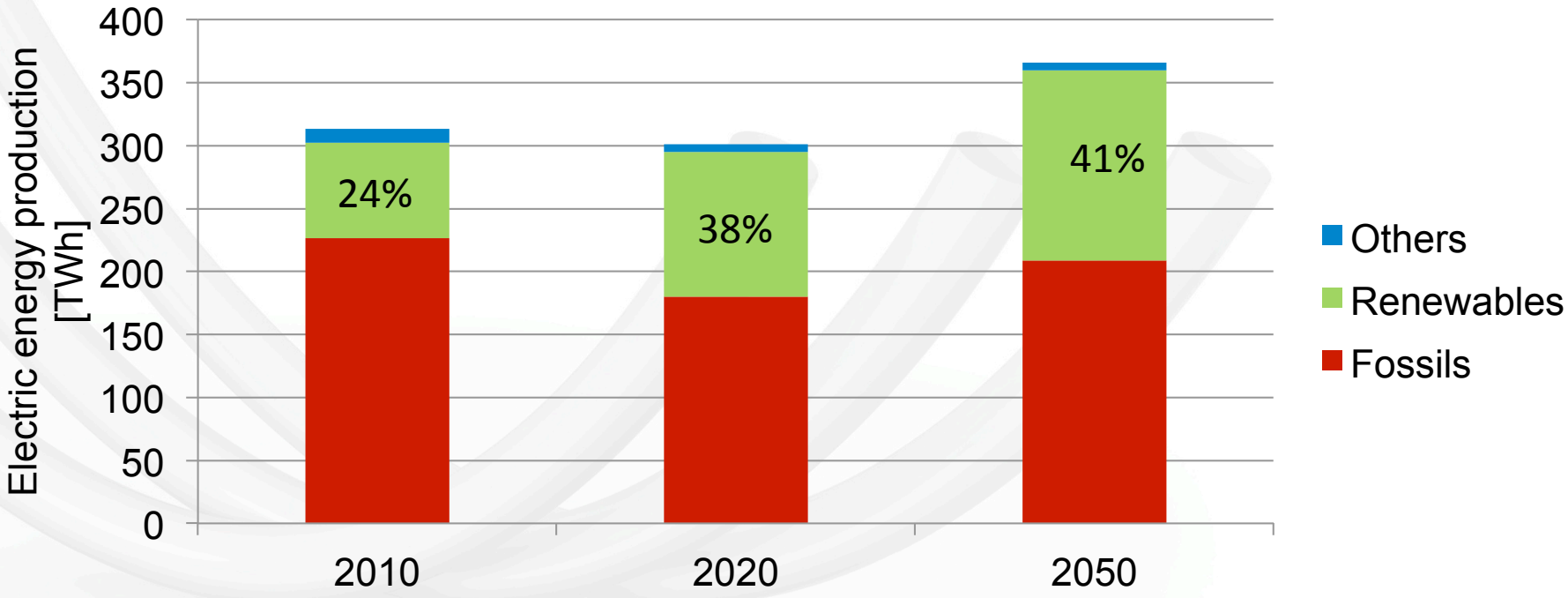
- Slight improvement in building technical systems efficiency.
- Extrapolation of electricity, natural gas and carbon (CO_2 emissions) prices up to 2050.
- Reduction of primary energy and CO_2 factors for electricity.

We also perform a second scenario assuming a cost reduction of EE and RES-based measures in addition to the previous hypotheses.

Scenario of the Italian power system up to 2050

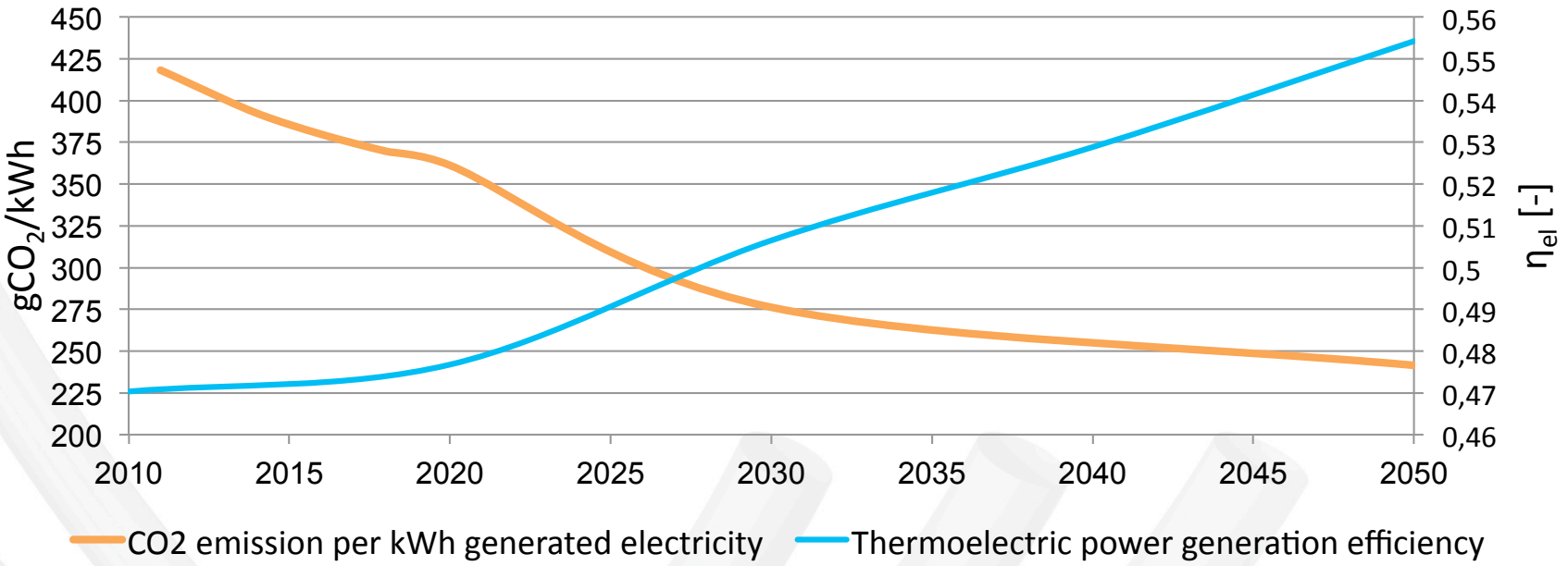
Main hypotheses:

- achievement of NREAP (National Renewable Energy Action Plan) targets;
- exception for photovoltaic plants (because they have already exceeded the target set for 2020);
- and abandonment of the Italian plan for nuclear power.



CO_2 and primary energy factor

CO_2 factor (or emission coefficient) is the quantity of CO_2 emitted to the atmosphere per unit of delivered energy

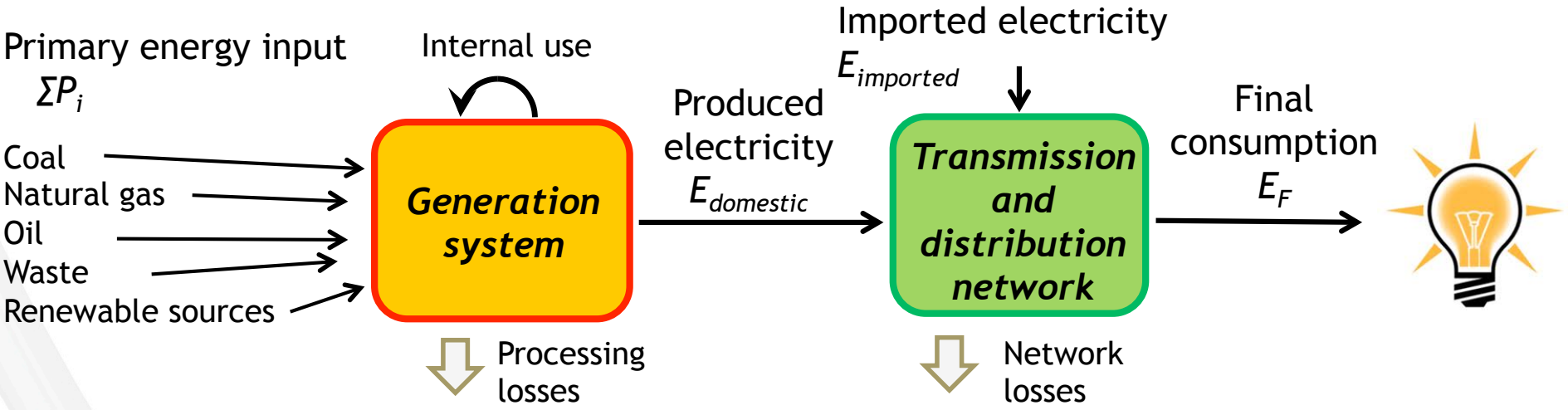


Primary energy is the energy that has not been subjected to any conversion or transformation process.

Primary energy factors are coefficients that allow to convert delivered and exported energy in primary energy.

Currently, in Italy, we use the values of 2,18 for electricity and 1 for natural gas.

Primary energy factor



$$\eta_{gen} = E_{domestic} / \sum P_i \qquad \eta_{net} = E_F / (E_{domestic} + E_{importe}$$

$$f_E = 1/(\eta_{gen} \times \eta_{net}) = \sum P_i / E_F \times E_{domestic} / E_{domestic} + E_{}$$

The average value calculated in the period 2020-2050 is 1,3 (non-renewable primary energy factor).

Comparative methodology framework

The comparative methodology framework is described by the Commission delegated regulation No 244/2012.

The methodology proposed by the Commission is articulated around 6 steps:

1) Establishment of reference buildings;
2) Identification of energy efficiency measures and measures based on RES;
3) Calculation of the primary energy demand;
4) Calculation of the global cost (in term of Net Present Value);
5) Derivation of a cost-optimal level of energy performance;
6) Sensitivity analysis on key parameters.

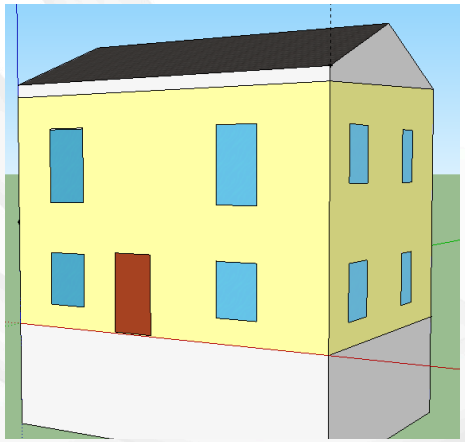
In this study we follow the Regulation but for sensitivity analysis.

Building typologies

The study is conducted on 4 new residential buildings, classified according 2 typologies and 2 locations.

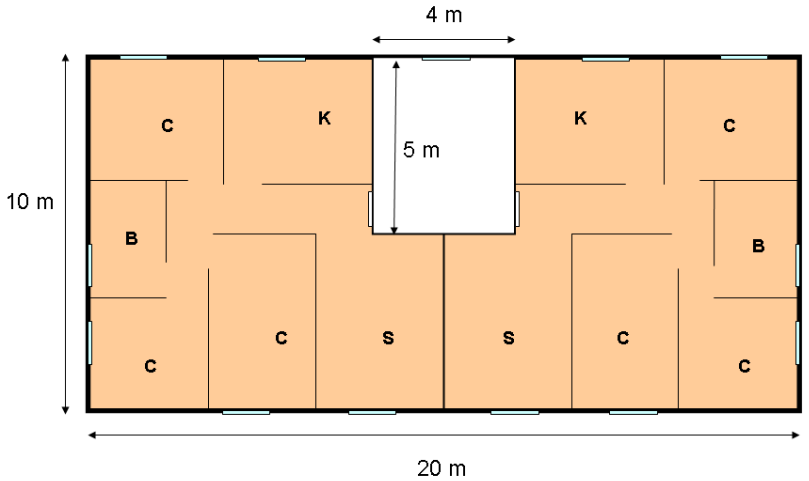
Single-family building

2 conditioned storeys
unconditioned attic
unconditioned basement
Total conditioned area: 150 m^2
S/V = 0,70 m^{-1}
Glazing area: 19,4 m^2



Multi-family building

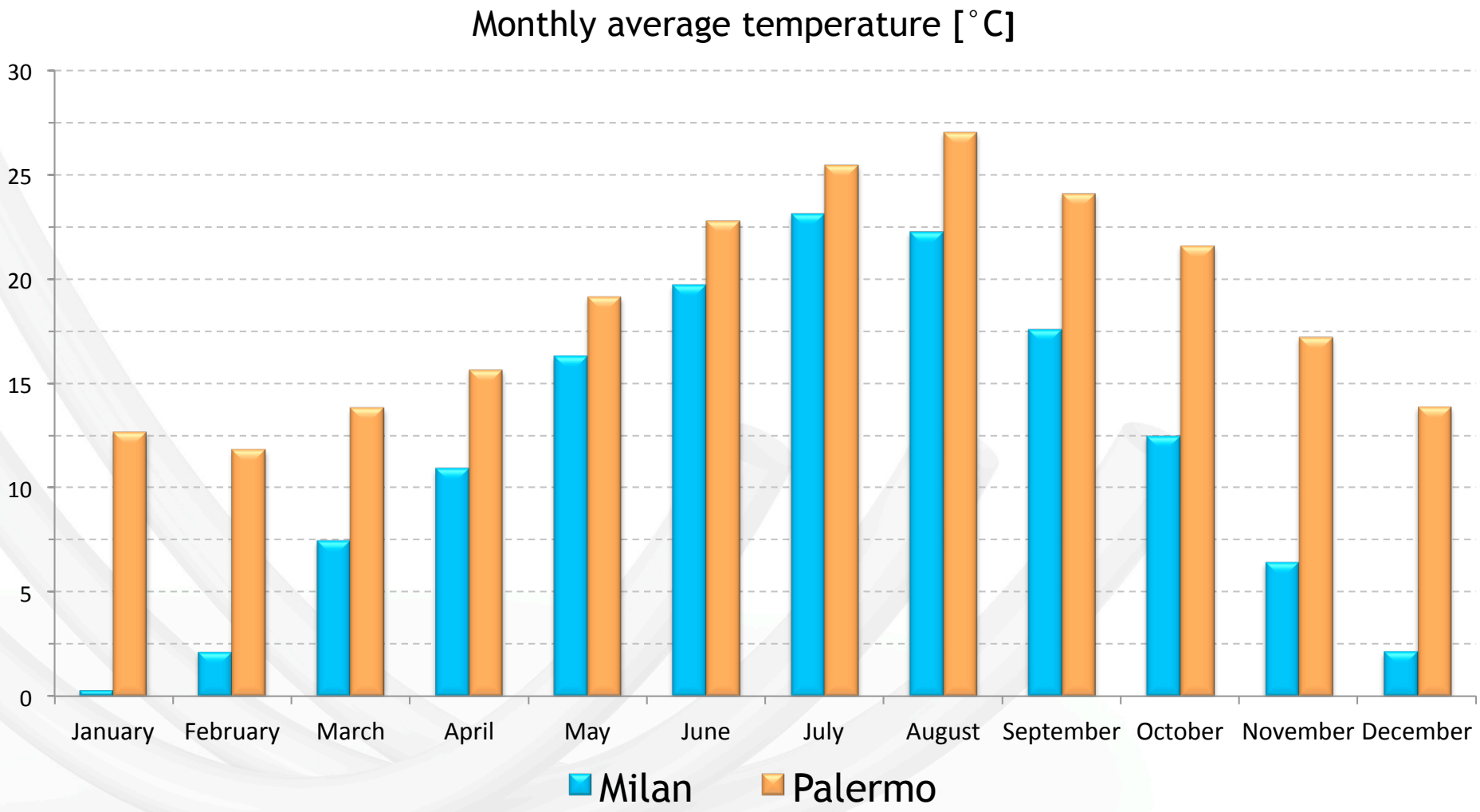
6 conditioned storeys (12 apartment)
unconditioned attic
unconditioned basement
unconditioned stairwell
Total conditioned area: 960 m^2
S/V = 0,46 m^{-1}
Glazing area: 129,6 m^2



Locations

Milan (climate zone E, 2404 HDD)

Palermo (climate zone B, 751 HDD)



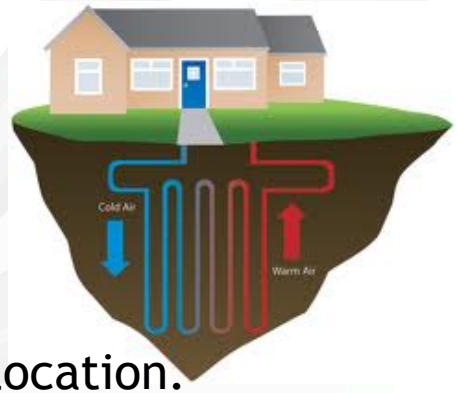
Source: ASHRAE 2011, International weather for Energy Calculation (IWEC Weather files)

EE and RES-based measures

- Opaque envelope thermal insulation
  - 3 levels of U-value

- Glazing systems
  - 4 typologies ranging from double glazing to Ar-filled triple glazing with coating
- Shading devices

- Mechanical ventilation with heat recovery
- Heating and cooling systems
  - Condensing boiler, aerothermal and geothermal heat pumps, CHP
- Solar thermal collector
- Solar photovoltaic collector



For each measure we consider up to 5 variants.

Measures are adapted to building typology and location.

Calculation

Building energy needs for heating and cooling are calculated with hourly dynamic calculation method described in ISO EN 13790.

Heating and cooling systems efficiencies are estimated on a seasonal basis.

Primary energy is calculated assuming the same primary energy factors for delivered and exported energy carriers:

$$E_p = \sum_i (E_{del,i} - E_{exp,i}) \times f_i$$

The calculation of the global cost, in term of net present value, is done according to standard EN 15459.

Two perspectives are analyzed: financial and macroeconomic:

Financial perspective

- ✓ point of view of an investor;
- ✓ prices as paid by consumer including taxes;
- ✓ discount rate of 5%.

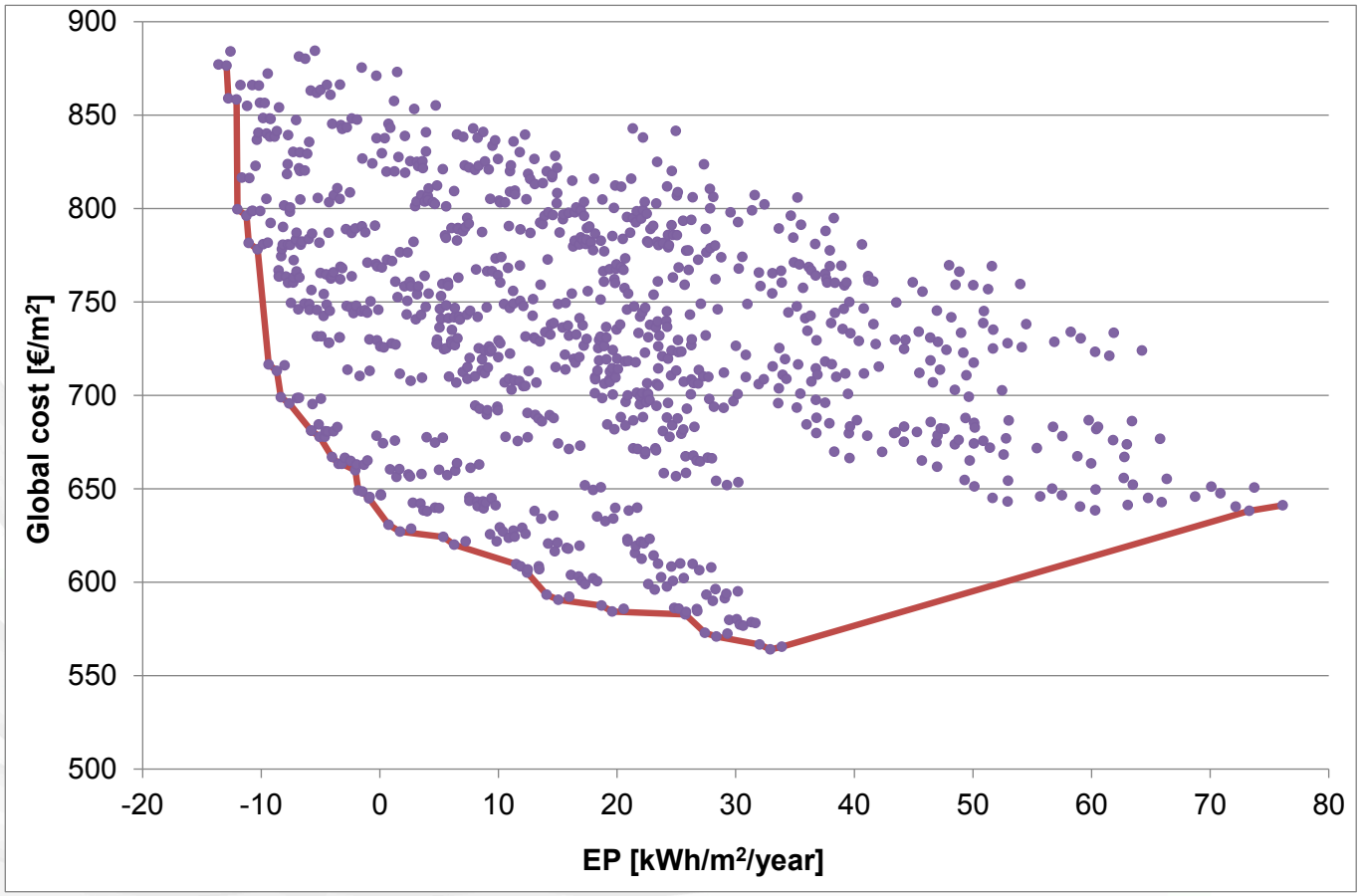
Macroeconomic perspective

- ✓ societal point of view;
- ✓ greenhouse gas emission costs;
- ✓ no taxes
- ✓ no subsidies;
- ✓ discount rate of 3%.

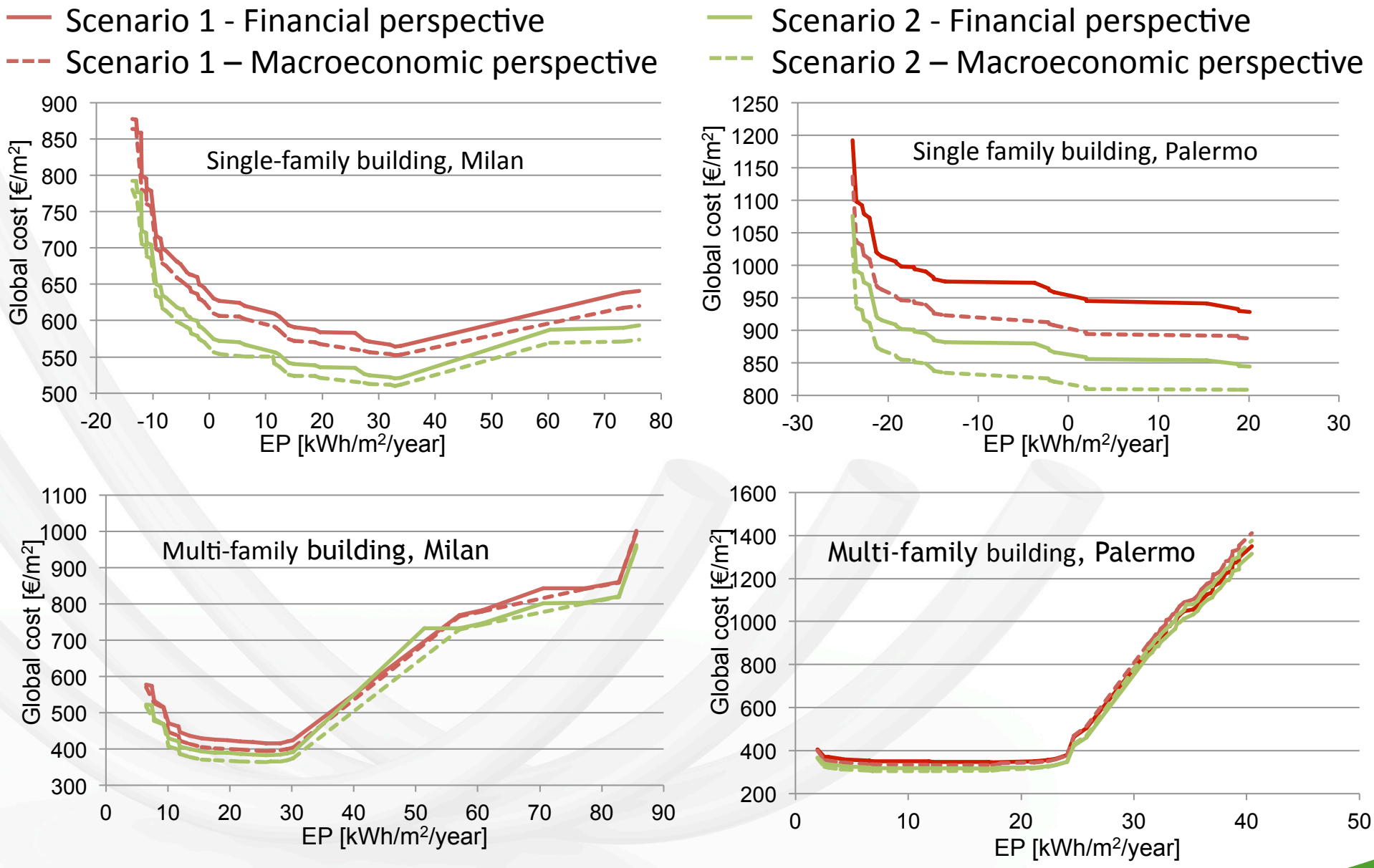
Cost curve

Each point represents a combination of measures.

The cost-curve (global cost vs energy performance) is defined as the lower border of the area marked by the points.



Results


Scenario 1 - Financial perspective
Scenario 1 – Macroeconomic perspective
Scenario 2 - Financial perspective
Scenario 2 – Macroeconomic perspective
Single-family building, Milan
Single family building, Palermo
Multi-family building, Milan
Multi-family building, Palermo
Global cost [€/m²]
EP [kWh/m²/year]

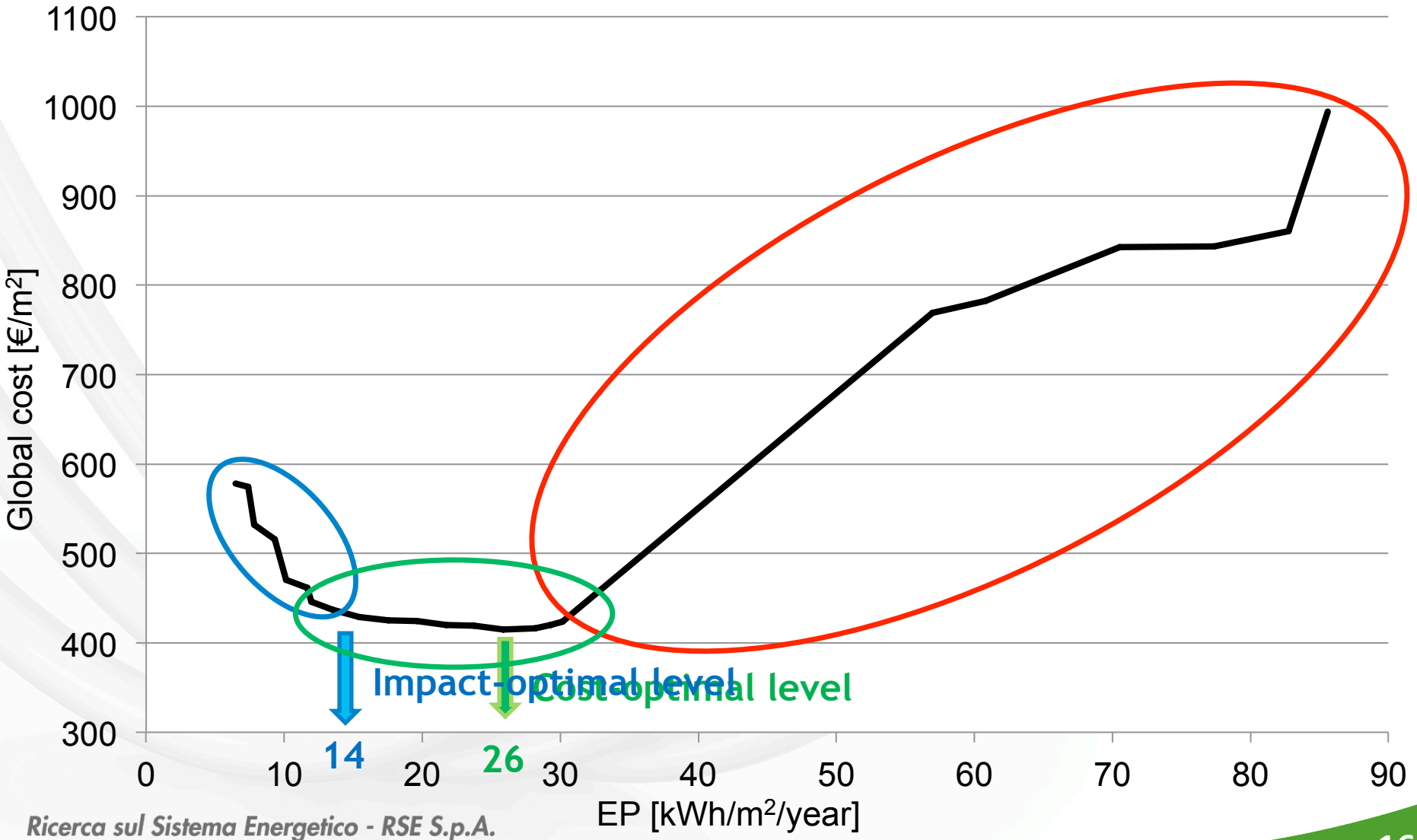
Trends

Left-hand zone: the economic impact reduces with increasing EP

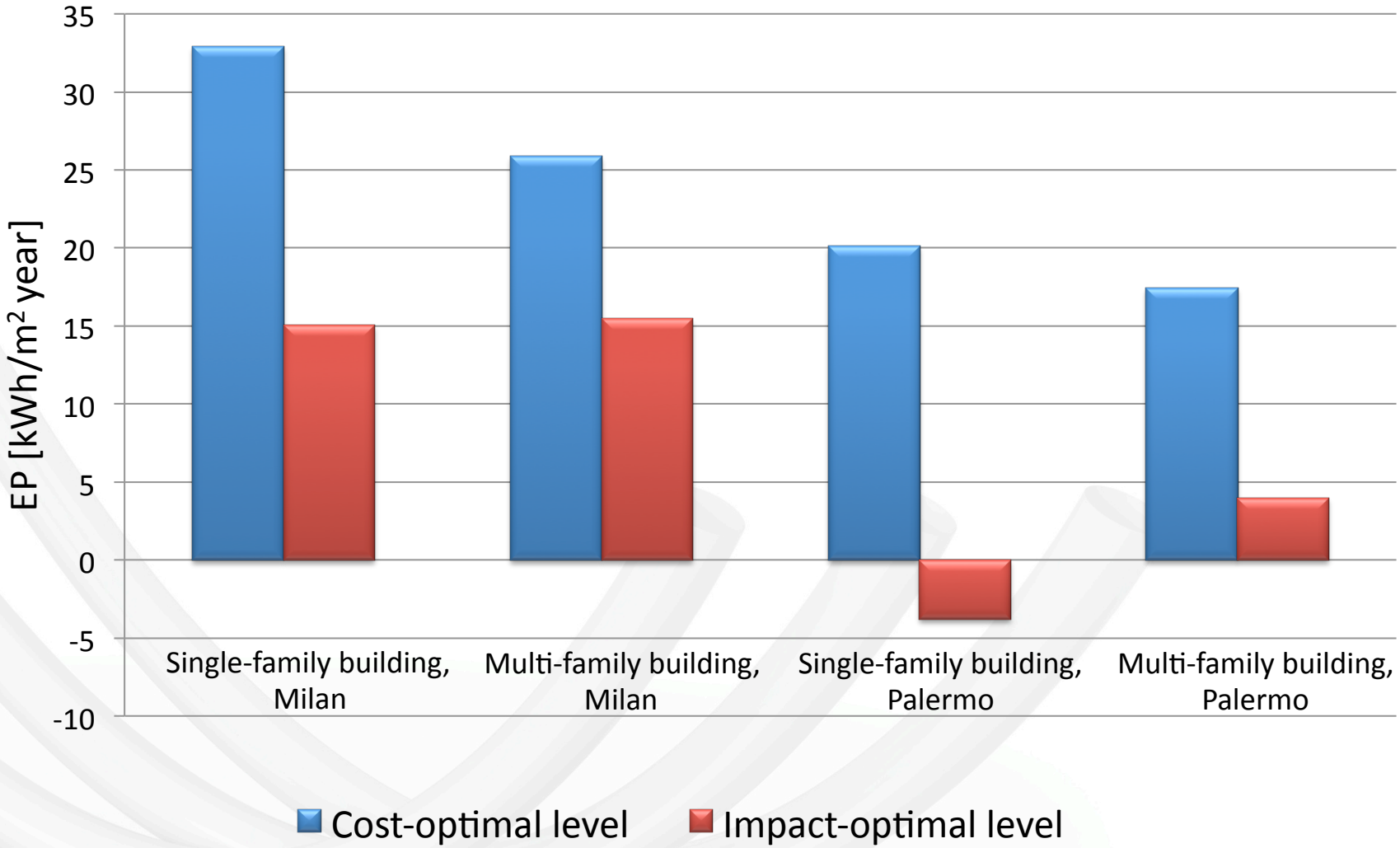
Right-hand zone: increasing the economic impact results in a poorer energy performance

Central plateau: cost-optimal level lies in this zone where the global cost varies very little

TO BE AVOIDED AND NOT ALLOWED



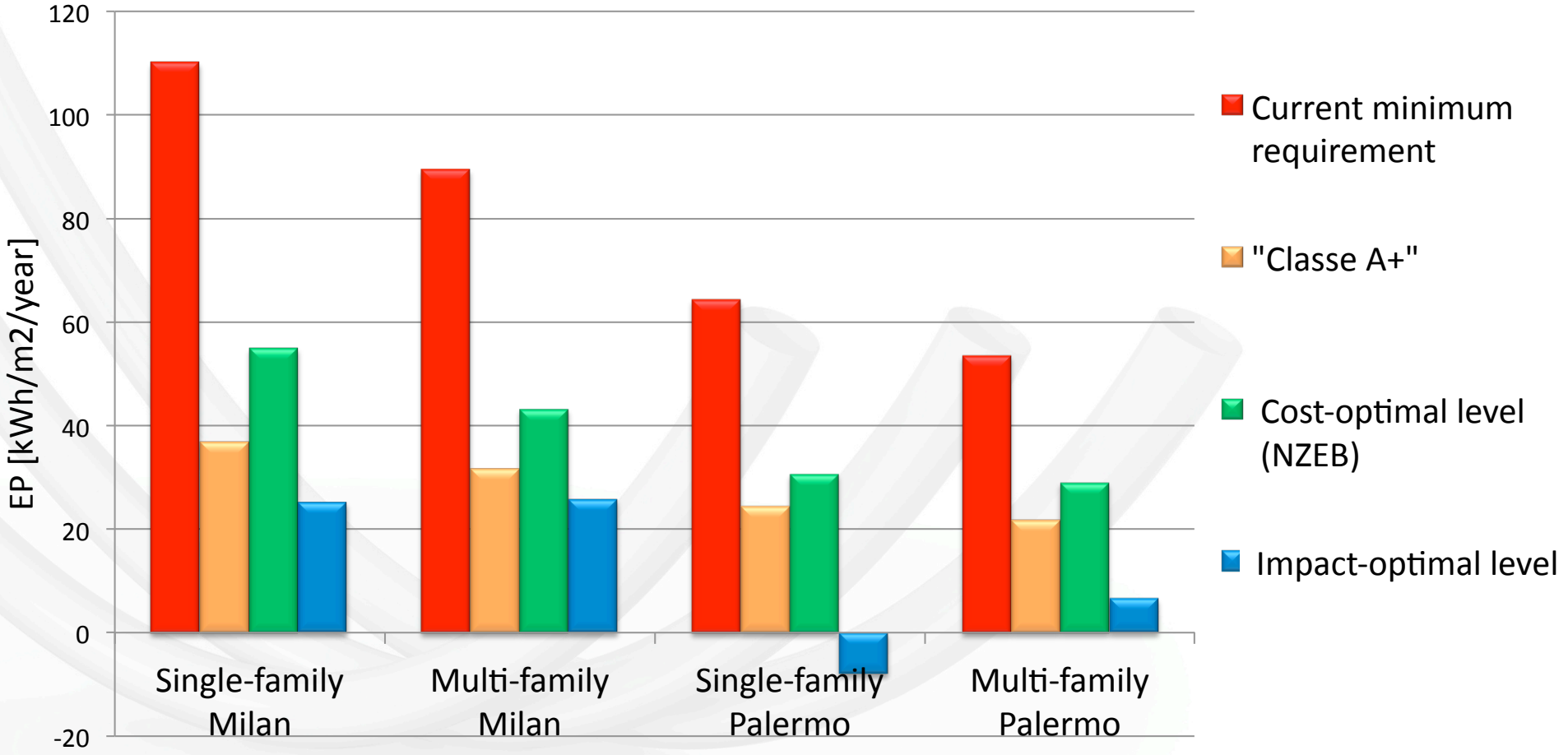
Cost-optimal and impact-optimal levels



Comparison with current requirements and best practices

With the sole purpose of a correct comparison with current minimum requirements we repeat simulations using the primary energy factors currently in use in Italy.

We correct current requirements and “Classe A+” performance in order to take into account primary energy use for space cooling.



Thank you for the attention!

Conclusions

NZEB definition simulating the application of the comparative methodology framework in 2020.

Cost-optimal vs impact-optimal

Thank you for the attention!

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