Cost-optimal assessment for energy efficient buildings

Integration of thermal comfort, productivity and health benefits

Sérgio Tadeu
tadeu.sergio@usp.br

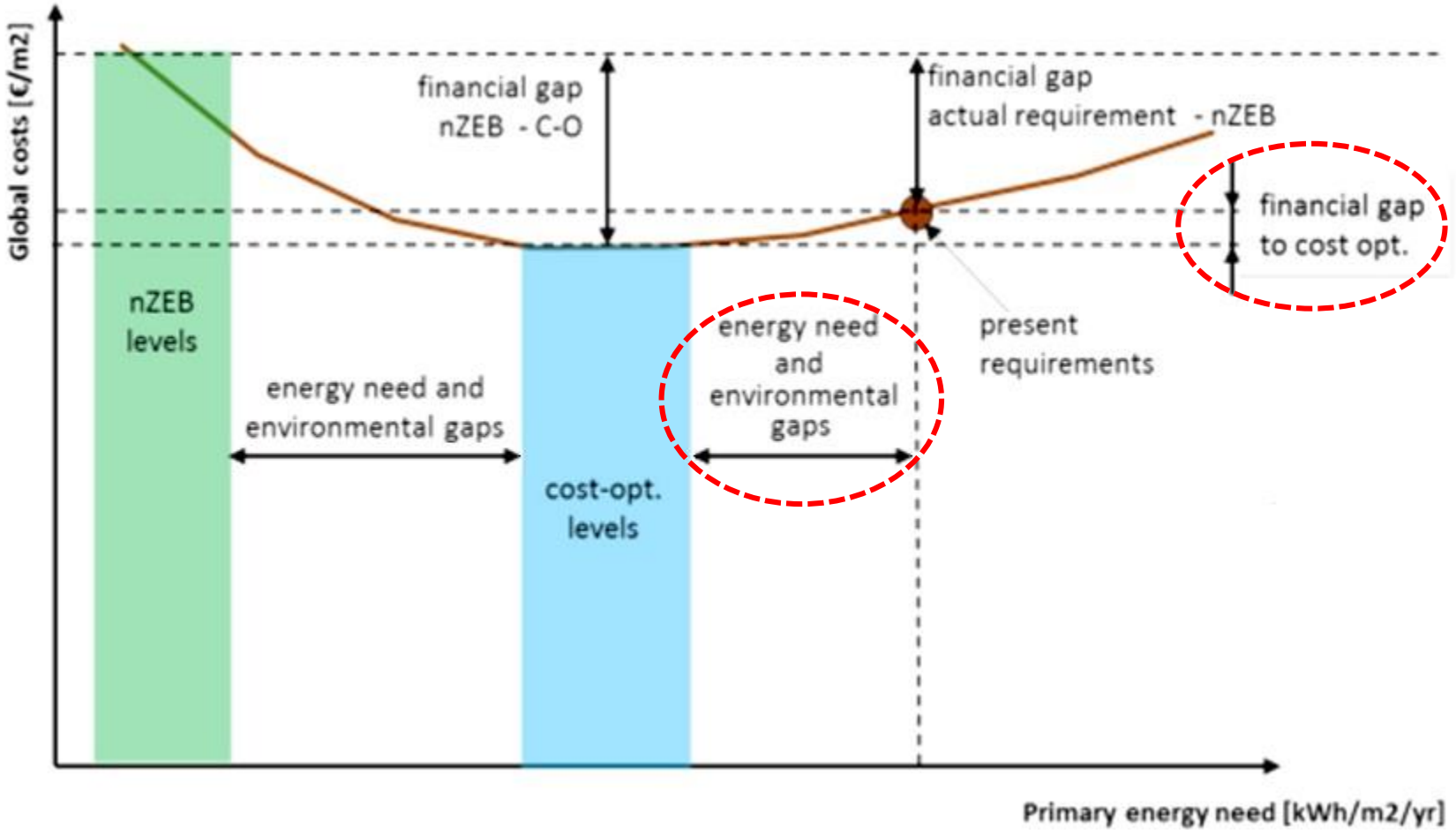
Cost-optimal assessment for energy efficient buildings

Deciding to **invest in energy retrofit** of buildings can be a complex process since it involves **multiple criteria** and objectives that are sometimes conflicting.

This **complexity** can discourage building owners from investing. In the absence of data and guidelines, **decisions** tend to be postponed or taken at a subjective level.

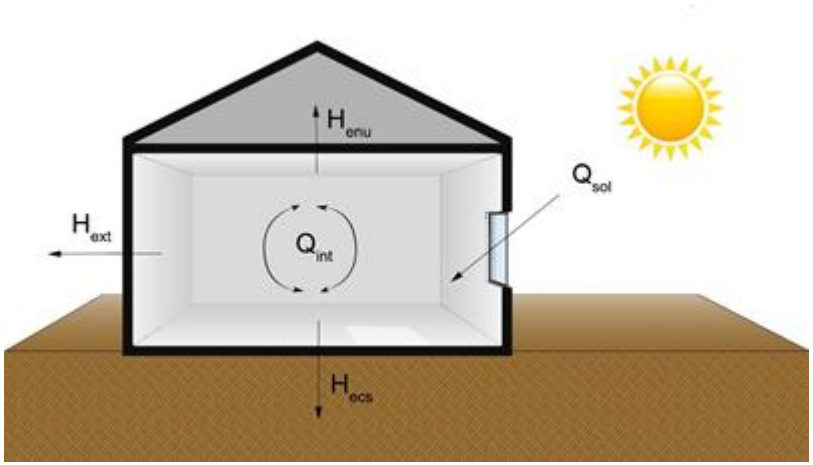
Thus, there are advantages to performing a data analysis that can improve the consistency of decisions and also promote the **social**, **environmental** and **economic** sustainability of energy retrofit measures.

Cost-optimal assessment for energy efficient buildings



Cost-optimal assessment for energy efficient buildings

$$PE = \left[\sum_{k=1}^{K_h} \frac{f_{h,k} \cdot E_{h,k}}{\eta_{h,k}} P_{h,k}\right] + \left[\sum_{k=1}^{K_w} \frac{f_{w,k} \cdot E_{w,k}}{\eta_{w,k}} P_{w,k}\right] - \left[\sum_{k=1}^{K_r} E_{r,k} \cdot P_{r,k}\right]$$



Energy balance - Seasonal method

$$GC = \sum_{j=0}^{J} \left[\sum_{i=0}^{\tau} IC_{i,j} \cdot D_i + EC_{i,j} \cdot D_i + GHG_{i,j}\right]$$

$$AI(\tau) = \sum_{j=1}^{J} \left[\sum_{i=0}^{\tau} IC_{i,j}\ D_i\right] - \left[\sum_{i=0}^{\tau} IC_{BAU,i,0}\ D_i\right]$$

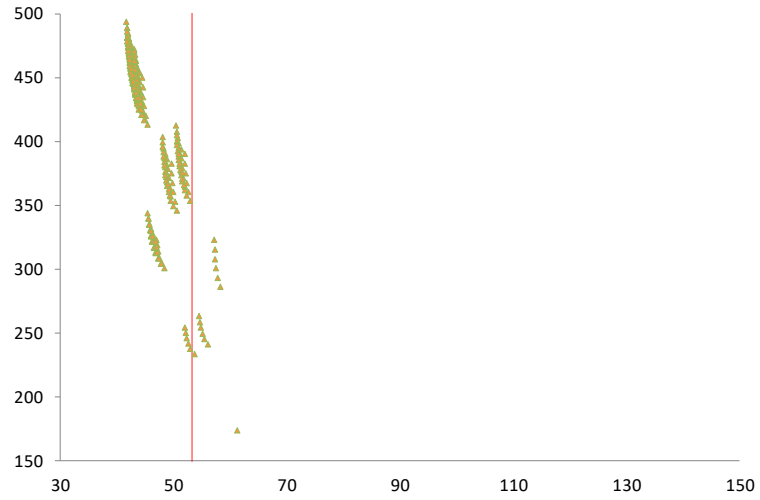
HEATING

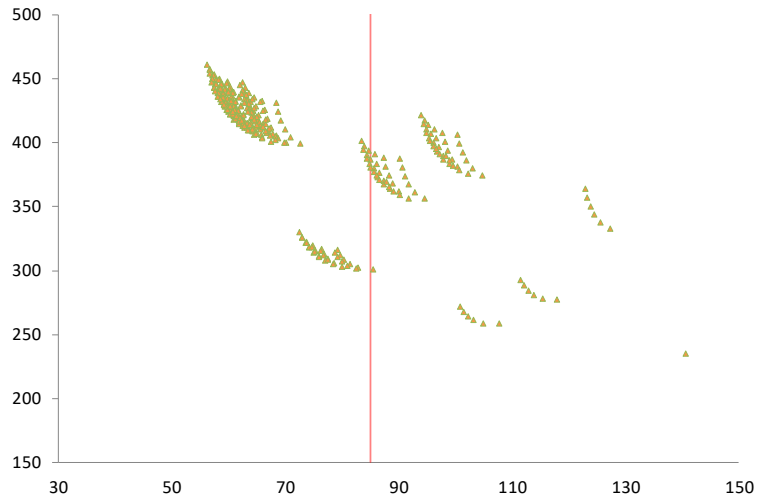
HIGH EFFICIENCY - COP = 4,3

LOW EFFICIENCY - COP = 1,0

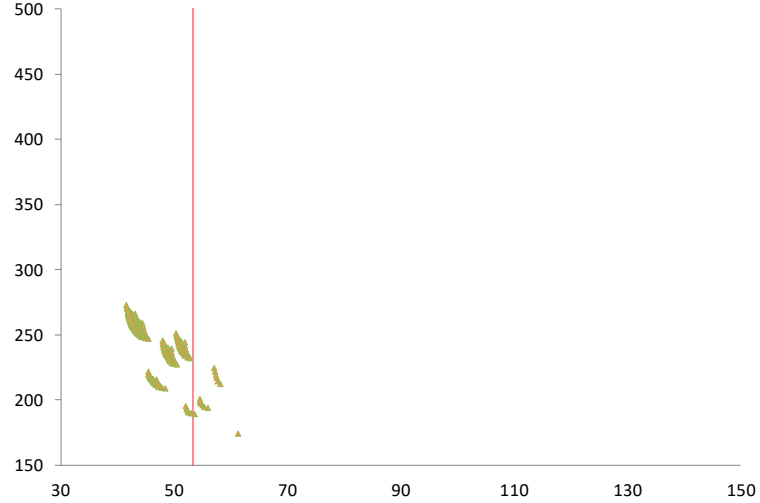
INSULATION

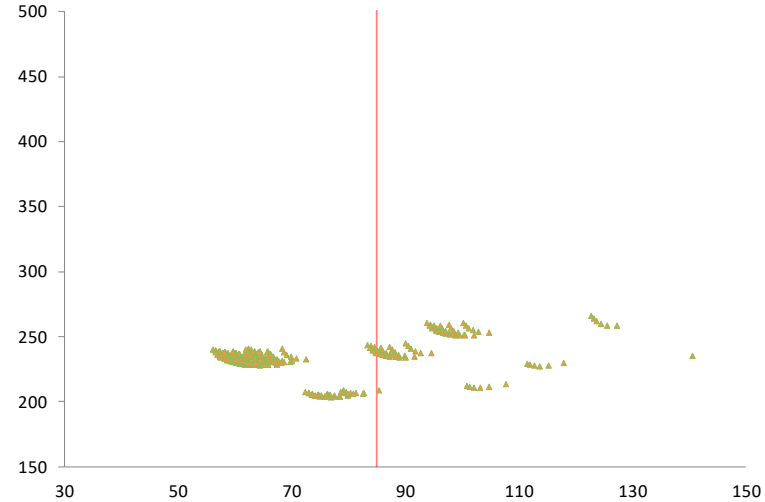
UPPER BOUND = 26,96 [€/R]





LOWER BOUND = 9,81 [€/R]





Cost optimality: Integration of thermal comfort, productivity and health benefits

1. The **cost-optimal methodology** involves a balance between costs and energy savings throughout the lifecycle of the building. There is a large level of flexibility when selecting the input data for calculation (reference buildings characteristics, discount rates, energy costs, investment costs, …). Currently, the first challenge that I wish to address is to develop a **multidimensional approach** focused on the **owner perspective**.

2. Buildings with low comfort levels are associated with **health problems** and can have a **negative economic impact**. It can imply direct medical costs or indirect costs related with lower productivity levels (reduction of the individual performance due to, for example, higher absenteeism). This fact justifies the major challenge which is to introduce the **cost dimension associated with health** on cost-optimal approaches.

3. Solving cost-optimal problems is a highly time-consuming process and there is a **lack of experience** among **energy experts**. As the objective is to contribute to the effective implementation of cost-optimal energy efficient solutions in buildings (including the comfort dimension), it is mandatory to provide tools contributing to the proficiency of energy experts, offering direct **benefits to owners**. The third challenge to address is the conversion of the multidimensional and complex problem into a **user-friendly tool**.

Data analytics on energy efficiency – The challenge

The problem is characterized by a large list of **variables** that need to be considered together: reference buildings, discount rates, energy costs, energy measures, inter alia. This multidimensional problem may be tackled using **multi-objective** optimization models.

The amount of possible combinations of efficiency measures hinders the selection of the cost-optimal ones by stakeholders: **authorities** (in policy making), **experts** (in the recommendation of corrective actions), **suppliers** of products and services (in their market positioning) and buildings **owners** (in the investment decision).

Data analytics on energy efficiency – One approach

First, the **selection of solutions** on common cost bases considering the suitability for reference buildings.

Step 2 involves performing **simulations** of the **energy performance** of combinations of the most competitive solutions that had been previously selected.

The third step is to calculate the **global cost** for the combinations of improvement measures.

At the end, a **sensitivity analysis** is performed by comparing the profitability for different scenarios.