HVAC benefits translated to building valuation

High performance HVAC solutions are often introduced to the market with characteristics phrasing their technical and environmental performance in terms of energy efficiency and indoor climate benefits. Yet these characteristics are often insignificant in the context of an overall building evaluation made by potential investors and it is useful to open a debate on a suitable assessment of HVAC benefits on building appraisal, taking into account "global costs" and considering functionalities, investments costs and operation and maintenance issues. This article aims at discussing the factors that allow the construction of a bridge between HVAC engineers and building investors and guidelines to translate typical HVAC systems benefits in the overall valuation of real estate are proposed.

Key words: building value, real estate investor, market value of building, value of HVAC, building owner, assessment of building

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The problem

While the environmental benefits of green buildings and high performance HVAC systems have been firmly established, their compelling financial and social benefits have been neglected. It happens in spite of the more and more importance of HVAC emerging technologies: research clearly shows that there are a large number of compelling benefits from using high performance HVAC systems, which are received by different stakeholders throughout building lifecycle. Actually, a building affects the workers where the building material are sourced, the workers that will work in the project, the community where it will be built. In economics terms the dilemma of a real estate investor is balancing all the stakeholders and translate the HVAC benefits to building valuation.

The drivers of market value

One issue that has remained controversial is whether it is possible to associate a financial value to the benefits of different HVAC solutions: this is crucial information for real estate lenders and the investment community. Do high performance HVAC solutions attract financial premiums in terms of rental and sales market value? Are they more attractive to tenants? Are employees provided of comfort technologies more productive?

To do that, investor must focus on his own long-term value creation: from the property's point of view this value creation corresponds to the building features the occupants look at when leasing or owning a building (Hines Italia, 2009). So, buildings with certain features will achieve a premium respect to other buildings. The key question is then what are those features that inves-

tors are looking for, and willing to pay a premium for. Data from literature are encouraging (IMMOVALUE project, 2010; Fuerst and McAllister, 2011; Wiley et al., 2010; Eichholtz et al., 2010), since there is evidence that the investors are willing to pay a premium for a sustainable buildings, and many characteristics of these buildings are closely linked to the installed HVAC systems. Actually, the *Market Value* of a building has three main components (or "drivers"): *Income*, *Expenses* and *Residual Value* as delineated by equation (1).

$$Market\ Value = Net\ Income - Expenses + Residual\ Value \quad (1)$$

The HVAC systems features have an impact on the three elements in the second term of equation 1, giving a contribution in the rent per area, in the rentable area, in the operation and maintenance expenses and also in the risk factors influencing the residual value of the building.

Income

Studies undertaken on certified green buildings have determined that a rental rate premium exists in many cases. This is attributed to the attractiveness in terms of their better indoor environment, lower operating costs and enhanced marketability. In some markets where green buildings are more mainstream, such as in USA, a slightly different concept is emerging: buildings that are not green result in lower rental and lease rates, or 'brown discounts'. In an office building the *Net Income* is given by the income related to *Rent* (net of expenses allocated to the owner) and other incomes related to productivity and reduction of absenteeism; thus, income can be increased by increasing rent or decreasing expenses allocated to the owner. However, rent can be further broken down into rentable area and rent per area.

$$Rent = Rent\ per\ Area \times Rentable\ Area \quad (2)$$

The *Rent per Area* is defined by many qualities that tenants or owners look for and high performance HVAC solutions could reflect. These qualities are related to the attractiveness to tenants in terms of indoor environmental quality (thermal, visual and acoustical comfort and indoor air quality), presence of individual automation control (BAC) and building management systems (BMS), together with the presence of facility management, continuous commissioning of the building services and an effective communication platform. Quality of common area and the image, which could be combined under the name "building best looking", could be affected by different solutions of HVAC systems, and represent reasons for choosing one building over another. The other variable in equation (2) is the *Rentable Area*. This is why space efficiency is such a critical measure. On the exact same plot and in the exact same building envelope, an efficient building with clear, regular floor plates and minimal core areas will create more usable space, i.e. rentable area. This creates more rent, which increases income and in turn increases value for the investor. A successful business "learns" and evolves quickly, and the workplace needs to respond to changes in use: flexibility of layout is an important dimension of the primary design and planning of the workplace's layout and systems. In addition to the level of the income, the investor is also focused on the *stability of the income*. Thus, it is important to keep the building and its HVAC system modern and up-to-date. Tenants that are satisfied with the quality and efficiency of their occupancy spaces are less likely to look for new quarters when their lease terminates. Less turnover provides a more stable cash flow and therefore higher value for the owner. High performance HVAC systems can improve *worker's productivity* and *occupant's health and wellbeing*, resulting in bottom line benefits for businesses. Literature data show that the effects of the thermal environment and air quality on human performance and learning can be much higher than 1% (Rehva Guidebook n.6). This suggests enormous potential benefits from improving indoor climate in relation to the investments required, considering that worker salaries in offices typically exceed building energy and maintenance costs by a factor of approximately 100, and they exceed the annual amortized cost of construction or rental by almost the same factor. Case studies demonstrate benefits of providing individual temperature control for each worker measuring productivity gains and demonstrating up to a 3% increase in overall productivity, while improving ventilation with up to 11% gains in productivity, as a results of increased outside air rates, dedicated delivery of fresh air to the workstation and reduced level of pollutants.

Expenses

Certified green buildings tend to use less energy and water and are therefore often cheaper to own and operate, making them more attractive to prospective tenants and owner-occupiers where energy and water costs are a major concern related to overall costs, including rents.

Operating expenses (**Figure 1**) for HVAC systems typically include the *Energy* costs for electricity, heating and cooling. Energy efficiency measures permit to reduce energy costs. However, considering a holistic approach as cost optimal analysis, a significant reduction of energy costs is coupled with high investment costs. The energy use is closely linked to the *Emissions* of pollutants (mainly

CO_2) in atmosphere and the cost of the reduction of the emissions can be used as a way to determine market value pollutants in an established trading markets. Actually, the Guidelines of Directive 2010/31/EU define the calculation of the cost optimum at macroeconomic level and it requires the consideration of greenhouse gas emission costs by taking the sum of the annual greenhouse gas emissions multiplied by the expected prices per ton CO_2 equivalent greenhouse gas emission allowances issued in every year (20 EUR/ton in 2020; 35 EUR/ton until 2030 and 50 EUR/ton until 2050). HVAC system expenses are also due to both *Operation and Maintenance* and *Continuous Commissioning* activities. HVAC solutions that are designed and operated to reduce the operation expenses will increase the income for the owner because tenants with lower operating costs can spend more money on rent. This in turn translates into more value for the investor. Furthermore, HVAC systems over the years could lead to *Major Refurbishment* costs because of the lack of functionality of the old system. This is another parameter to account in the analysis of the expenses.

Residual value

The residual value of a building and HVAC system should reflect investor risk related to the potential reduction in value or increase in costs associated with holding an investment (World Green Building Council; 2013). There are different risks (**Figure 2**) related to the HVAC system that could be evaluated at the different stage of building life cycle, but all can be considered ways to "future-proofs" investments.

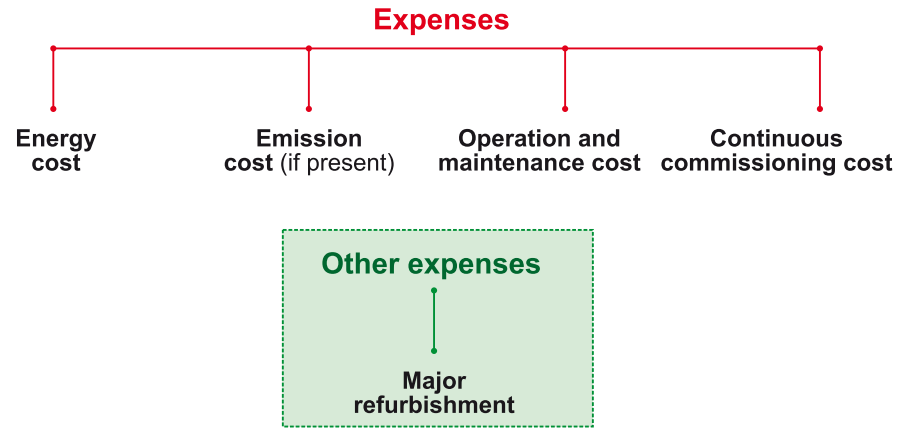

Figure 1. Classification of expenses for HVAC systems.

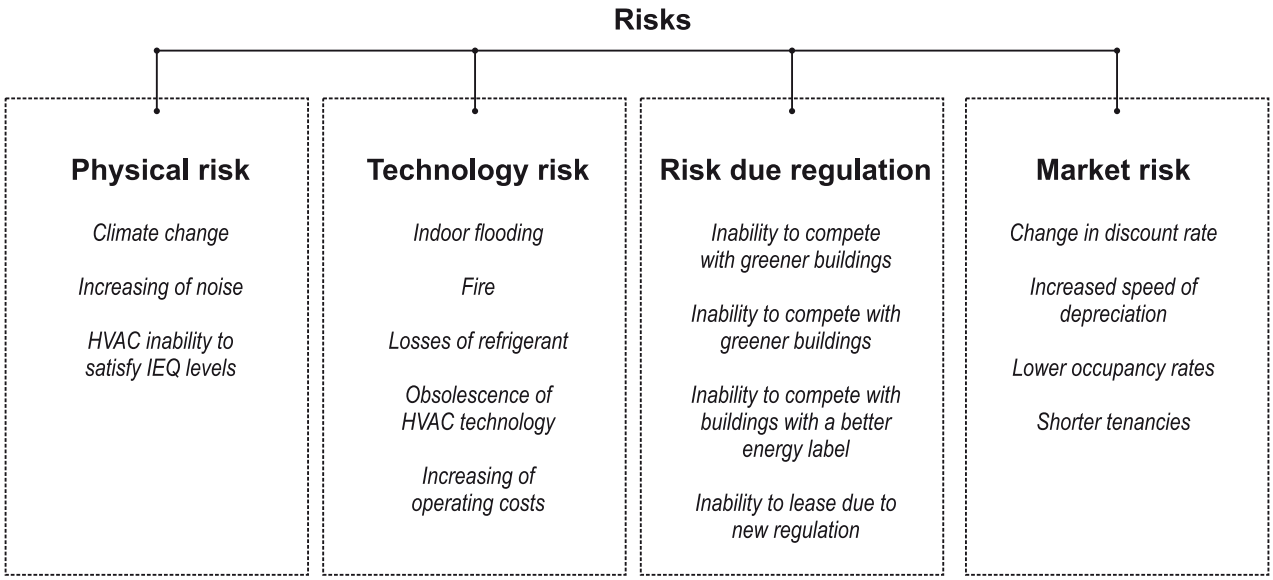

Figure 2. Risks classification for HVAC systems.

Climate change represents a real *Physical risk* for investors: chief among the climate change impact will be the ability of the HVAC systems to cope with the foreseen increased temperature of the planet. For this reason, investors should consider the ability of HVAC systems to ensure that the building's occupants will view premises as desirable (HVAC inability to satisfy adequate indoor environmental quality levels). Actually, there is a cash flow risk for buildings which are not enough resilient to face future climatic challenges and to ensure occupant's satisfaction. Innovative technologies like new HVAC equipment have their own risks (*Technology risk*), arising from unintended outcomes from their use or concerns about appropriate maintenance regimes. However, reticence to use new technologies could increase the risk of obsolescence and could miss opportunities for reduced operational costs. Regulation of sustainability issues, like reduction of carbon emissions, has become increasingly important to real estate investors, since the built environment is regarded as responsible for significant environmental impact. The *Risk due to regulation* is reflected by the inability of existing asset to compete with greener buildings, or with buildings with a better energy label. There is increased consensus that governments will implement regulations that target sustainability factors more forcefully than has previously been the case: actually this is reflected by the inability to lease buildings without high performance HVAC systems due to new regulation. As well as responding to regulatory pressure, real estate investors simultaneously need to understand how high performance HVAC solutions affect them from a market perspective (*Market risk*). The financial performance and valuation of a real estate asset is to a large part determined by the security of its cash flow. The likelihood that tenants might leave a building (lower occupancy rates) or not lease it in the first place (shorter tenancies), because of its inadequate performance in terms of energy and indoor environmental quality, is also recognized as a key risk by investors. As more high performing buildings (with high performance HVAC systems) become available and occupants become less willing to occupy not-performing buildings, it will increase the speed of their depreciation.

HVAC benefits valuation

The HVAC benefits are the factors leading to an added investment value for the building, actually they could be translated in "*quantitative indices*" (i.e. the energy costs for controlling the indoor environmental conditions or operation and maintenance costs) and "*qualitative indices*" (i.e. the characteristics of the system in order to allow modification in building layout or the best looking). The quantitative indices could be expressed as costs in Euros while qualitative indices, that can't be directly expressed in Euros, could be expressed as correction coefficients (**Table 1**).

Energy use, pollutants emission, continuous commissioning and O&M expenses are categorized as quantitative indexes. Flexibility of layout in space and time, comfortable indoor environmental conditions as well as best looking are categorized as qualitative indices that affect the income by the rent per area and the rentable area values.

Table 1. HVAC systems influencing factors and costs (for each HVAC typology).

Expenses, €	Energy cost Emissions cost O&M Continuous Commissioning cost	***QUANTITATIVE INDICES***
Net income factors	Flexibility [f_1] IEQ [f_2] Best looking [f_3] BAC [f_4] BMS[f_3]	***QUALITATIVE INDICES***
Residual Value factors	Losses of refrigerant [z_1] Indoor flooding [z_2] Fire [z_3] HVAC technology obsolescence [z_4] Increasing of operation costs [z_5]	

The risks factors in **Figure 2** are categorized as qualitative indices affecting the residual value of the building. Looking at equation 1, both the quantitative indexing factors and the qualitative indexing factors can be inserted modifying directly the market value (correcting the income or the residual value, increasing or decreasing the expenses). Then it becomes:

$$Market\ Value = f_{1,2,3,..,n} \times Net\ Income - Expenses + z_{1,2,3,...3,n} \times Residual\ Value \quad (3)$$

Discussion

It has been highlighted the fact that HVAC systems benefits are not considered yet in the current market valuation and the problem of how market could integrate these benefits is crucial and relevant for the HVAC industry. The research on the methodology to evaluate the benefits linked with the installations of high performance HVAC system arose interesting discussion points. It's very important to find a method to evaluate the qualitative benefits related to income and the risk factors related to residual value. As above mentioned, an increase in comfort conditions could gain an increase on productivity and reduction of the so called "sick building syndrome", but the issue of comfort is not actually translated in money, which is an important aspect to consider when investing in a building. Between the qualitative benefits related to income, the presence of BACs could be expressed by default in a quantitative index as the reduction of energy cost (see standard EN 15232 "Impact of building automation, controls and building management"). The topic of risk assessment is of crucial relevance: risk factors have be included in the HVAC valuation, but it still remains difficulties in assessing the investment risks related to high performing buildings and systems. Between the risk factors related to residual value, some of them could be reduced by an increase of O&M and continuous commissioning costs. Maintenance best practice integrate management of risk and an interesting passage for HVAC industry should be moving from selling only products to sell after sale services. To find a way of communication from HVAC industry to investors is a fundamental aspect in order to correctly translate all the HVAC benefits in the market valuation. Therefore a work table of technicians and investors is fundamental to have a more integrated perspective. ■

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