

European Valuer

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Business valuation in times of crisis

Tbilisi, Georgia

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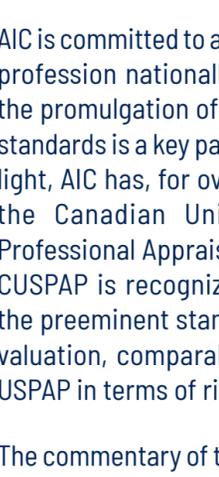
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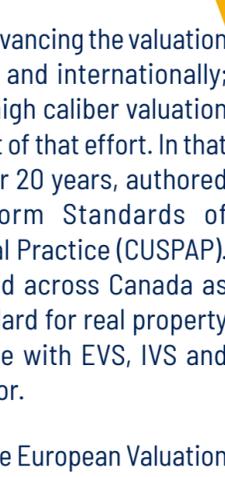
REAL ESTATE VALUATION

#01

Prudently Conservative Valuation Criteria – Are they prudent?



Suzanne de Jong



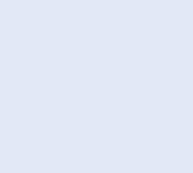
Keith Lancaster

The Appraisal Institute of Canada (AIC) is a proud observer member of TEGOVA; we have, in concert with our European colleagues, worked hard to advance the valuation profession on both sides of the Atlantic.

AIC is committed to advancing the valuation profession nationally and internationally; the promulgation of high caliber valuation standards is a key part of that effort. In that light, AIC has, for over 20 years, authored the Canadian Uniform Standards of Professional Appraisal Practice (CUSPAP). CUSPAP is recognized across Canada as the preeminent standard for real property valuation, comparable with EVS, IVS and USPAP in terms of rigor.

The commentary of the European Valuation Standards Board on the “prudently conservative valuation criteria” (“PCVC”) in the Capital Requirements Regulation currently in the EU legislative pipeline is one of a number of discussions focusing on the inclusion of “prudent value” or PCVC as one of the approaches that an appraiser / valuer could be asked to provide their client. As we understand, this concept is similar to the “mortgage lending value” that has been relied upon in some EU member states since the aftermath of the 2008-09 financial crisis.

AIC has long had significant concerns with this approach and does not stand alone. Based on discussions with other appraisal bodies – including those from the United States – neither “prudently conservative valuation criteria” nor “mortgage lending value” would be well received in many parts of the world, nor is it a necessary inclusion for appraisers working in many markets.



Bruxelles, le 27.10.2021
COM(2021) 664 final
2021/0342 (COD)

Proposition de

RÈGLEMENT DU PARLEMENT EUROPÉEN ET DU CONSEIL

modifiant le règlement (UE) n° 575/2013 en ce qui concerne les exigences pour risque de crédit, risque d'ajustement de l'évaluation de crédit, risque opérationnel et risque de marché et le plancher de fonds propres

(Texte présentant de l'intérêt pour l'EEE)

(SWD(2021) 320) - (SWD(2021) 321) - (SEC(2021) 380)

FR

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While we empathize with, and fully support, the need to properly regulate mortgage lending to better protect marketplaces and consumers, we contend that the responsibility for that properly lies with lenders and the entities charged with regulating their conduct.

The concept of PCVC or mortgage lending value, calculating a future value (that may include a reduction from the current market value) to determine the appropriate amount of a mortgage or investment, is the responsibility of the lender or investor – and, by extension, of the regulator(s) responsible for overseeing those activities.

A requirement for an appraiser to apply prudently conservative valuation criteria unduly shifts the burden of liability to the appraiser from those that stand to benefit from the transaction and therefore should properly carry it. This requirement would essentially see the valuer serve as a de facto guarantor of the value of the loan or investment, a level of risk exposure far beyond that which an individual appraiser should reasonably undertake.

“A requirement for an appraiser to apply prudently conservative valuation criteria unduly shifts the burden of liability to the appraiser from those that stand to benefit from the transaction and therefore should properly carry it.”

The reputational risk associated with these types of provisions is also significant as the appraiser would face serious criticism if a future market were to fall below the reduced level represented by a PCVC calculation. After all, a market value is understood to be a ‘spot value’, not necessarily valid at a future date, whereas the presumption will surely be that a value predicated on PCVC was supposed to be ‘devaluation proof’ into the future, as it was “adjusted to take into account the potential for the current market price to be significantly above the value that would be sustainable over the life of the loan” (future CRR Article 229(1)(b)(ii)).

And at a time when the profession, in a number of markets, is facing allegations of providing lower values due to biases, a requirement to provide such a subjective conclusion would counter efforts to reaffirm the fairness, impartiality and objectivity and hence reliability and trustworthiness of professional appraisers.

Further, as we understand, the PCVC calculation relies very heavily on the analysis of historical data. An overreliance on historical data will not necessarily provide an accurate outcome. As we have seen during the COVID-19 pandemic and as a result of the geo-political events of the last two years, markets can become extremely volatile in a short period of time. According to the Canadian Real Estate Association, in Canada – a country known for the stability of its real estate – the national housing price index dropped by over 18% in a one-year period (January 2022 – January 2023). In such times, it is hard to imagine a statistical model anticipating such volatility.

“the PCVC calculation relies very heavily on the analysis of historical data. An overreliance on historical data will not necessarily provide an accurate outcome.”

Neither the profession nor the marketplace is well served by the expansion of this beyond the EU for the reasons noted above. In fact, we would submit that every effort should be made to dissuade the EU from their current course of action on this front.

The marketplace, and the profession, would be better served with a more holistic regulatory approach to mortgage lending. One example of this is the B-20 guideline employed by Canada’s Office of the Superintendent of Financial Institutions (OSFI)². Under the guidelines, Canada’s federally regulated lenders must undertake a rigorous process that caps Loan to Value (LTV) rates, requires default insurance for high ratio loans, assesses current market values (determined by appropriate numbers of professionally prepared valuations) and requires individual borrowers to demonstrate a capacity and willingness to repay the mortgage loan. The current set of guidelines has been in place for over a decade and is widely credited as a key foundational element of Canada’s housing market.

In conclusion, AIC would encourage strident opposition to the inclusion of “prudently conservative valuation criteria” or “mortgage lending value” in future editions of EVS or in valuation methodology. Including any such reference would only serve to codify its use and would place significant pressure on the profession outside of the EU to adopt what is, with respect, a flawed approach to value determination.

We stand ready to provide support and insight to our TEGOVA colleagues as and when appropriate.

¹<https://www.crea.ca/housing-market-stats/canadian-housing-market-stats/national-price-map/>

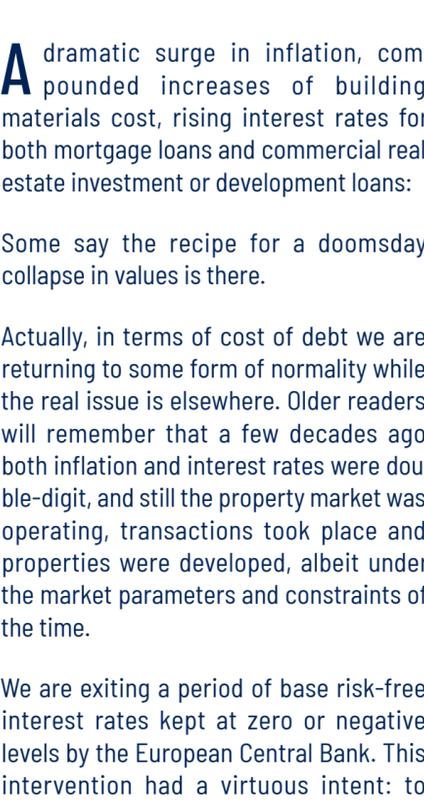
²https://www.osfi-bsif.gc.ca/Eng/fi-if/rg-ro/gdn-ort/gl-ld/Pages/b20_dft_let.aspx

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REAL ESTATE VALUATION

#02

Surging interest rates: Valuation doomsday or back to normality?



Jean-Paul Loozen

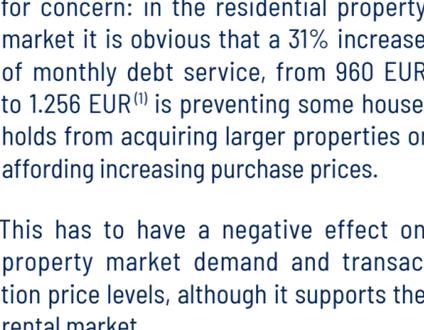
A dramatic surge in inflation, compounded increases of building materials cost, rising interest rates for both mortgage loans and commercial real estate investment or development loans:

Some say the recipe for a doomsday collapse in values is there.

Actually, in terms of cost of debt we are returning to some form of normality while the real issue is elsewhere. Older readers will remember that a few decades ago both inflation and interest rates were double-digit, and still the property market was operating, transactions took place and properties were developed, albeit under the market parameters and constraints of the time.

We are exiting a period of base risk-free interest rates kept at zero or negative levels by the European Central Bank. This intervention had a virtuous intent: to support economic growth with whatever it takes, by lowering the cost of financing for private sector investments, encouraging consumption and lowering the cost of public debt and hence supporting public spending for the same purposes.

At best this policy prevented recessions, but it did not fuel real economic growth. That is the main issue today: while the war in Ukraine kick-started European inflation by triggering an upsurge in energy prices on the international markets, the concept of Time Value of Money could not but come back into force after a temporary period of 'artificially low' interest rates, and the strong correlation of movements between interest rates and inflation has once again been confirmed, as can be seen in the graphs below.



Source: ECB - Interest rates - Eurozone



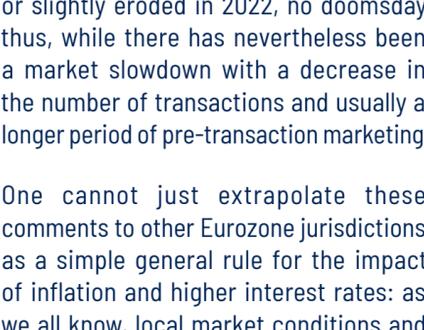
Source: ECB - Inflation - Eurozone

The current interest rates (May 2023) charged by lenders have not gone double-digit but remain stable at an historically reasonable and mid-range level. In that sense they have gone back to normality. The core of the matter for property valuers is elsewhere: the rise in interest rates is not generated by economic growth and accordingly is not offset by an increase in wages or a significant GDP progression.

In that context, the affordability of the cost of financing then becomes the real cause for concern: in the residential property market it is obvious that a 31% increase of monthly debt service, from 960 EUR to 1.256 EUR⁽¹⁾ is preventing some households from acquiring larger properties or affording increasing purchase prices.

This has to have a negative effect on property market demand and transaction price levels, although it supports the rental market.

It is not that simple though, as there's a flip-side: for private investors the annual return from equities, be it bonds, shares or financial deposits, is in the vast majority of cases lower than the general inflation, hence the assurance of losing investment capital value in real terms. This is illustrated by the following figure comparing nominal and real (after deduction of inflation) rates of the government bonds in Germany as an example of this pan-European trend:



Source: Epra

Periodic returns from annual rental income in the residential market are also affected by the same phenomenon despite the lingering hope – some say speculation – of protecting the capital value via resale in the mid- to long term, hence residential property investments for rental purposes are still taking place.

The same move towards 'tangible' assets was already true during the period of abnormally low interest rates of recent years, with a dramatic increase in mortgage loan volumes in banks' balance sheet assets, from 50 billion EUR in 2000 to 240 billion EUR in 2021 in Belgium (Source: BNB):



In that Belgian market I know the best, residential values – depending on location and type of properties – either remained steady or slightly eroded in 2022, no doomsday thus, while there has nevertheless been a market slowdown with a decrease in the number of transactions and usually a longer period of pre-transaction marketing.

One cannot just extrapolate these comments to other Eurozone jurisdictions as a simple general rule for the impact of inflation and higher interest rates: as we all know, local market conditions and practices vary – especially the level of property-related household indebtedness – and the analysis of how values behave has to take this into account:



Source: Deloitte Property Index; Hyposstat 2021

Unsurprisingly, commercial real estate has been affected in a way similar to residential assets: higher interest rates on the one hand, and higher Return On Equity (ROE) expectations to cope with inflation on the other, have driven up the weighted average cost of capital (WACC), not to speak of lenders being more cautious in terms of Loan to Value and Loan to Cost ratios.

In Western Europe this translates into higher investment yields, leading to negative value adjustments:



Commercial prime property yields Belgium as an example – Source: CBRE

One notes that the increase in yields has brought values back to a historically 'mid-range' and 'reasonable' level rather than confirming a market crash.

Very much as in residential markets, the core of the matter lies in the affordability and sustainability of property cash flow generation. Demand for business space is not drying up, however take-up volumes are lower than they used to be, and decision making is often delayed due to economic uncertainty.

“One notes that the increase in yields has brought values back to a historically ‘mid-range’ and ‘reasonable’ level rather than confirming a market crash.”

If we simplify the value as a ratio between rental operating income and investment yield, owners cannot control market driven yields and the relevance of asset management performance thus comes back with full force.

The effect of poor asset management on values has in recent years often been compensated by yield compression, a convenient smokescreen. Owners with above-average efficiency and results in all aspects of asset management will now stand out as the ones managing to prevent or slow down any decrease of value of their commercial real estate properties.

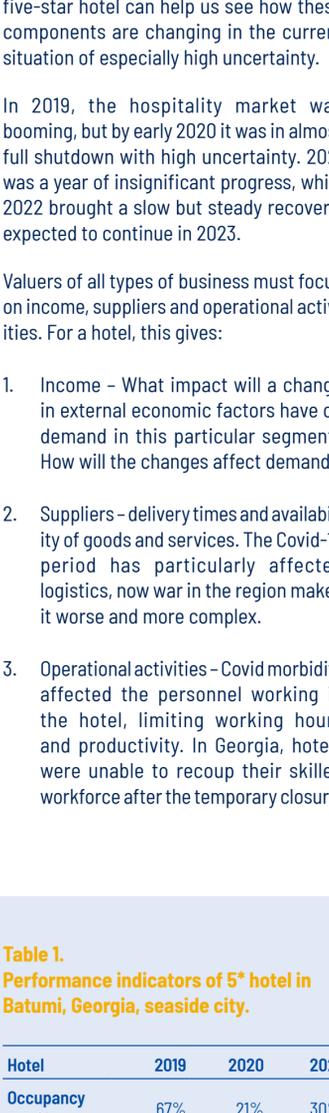
⁽¹⁾ A 200.000 EUR loan amortised over 20 years with a fixed interest rate of 1,45% or 4,5%/year.

Jean-Paul Loozen CF FRICS is the founding partner of Andersen Real Estate and Deloitte Real Estate Belgium & Europe, Middle East & Africa. He is the former practice director for Europe and North America.

He is the academic director of the post-graduate Executive Programme in Real Estate of the Solvay Business School of the Free University of Brussels, and the Chairman of the Board of BELGAVAL, the new Belgian Property Valuers National Association that recently joined TEGOVA.

BUSINESS VALUATION

#04 Business valuation in times of crisis – A hospitality industry case study



Nino Beraia

We live in times of colliding crises and high volatility of financial markets that significantly impact business valuation practice, even more so in small countries like Georgia with civil unrest and economic turbulence deriving from regional conflict and with local currencies under strong Euro and Dollar market influence.

There are three main drivers of business value: expected cash flows, risks connected with these cash flows, and growth rate. A hospitality industry case study of a five-star hotel can help us see how these components are changing in the current situation of especially high uncertainty.

In 2019, the hospitality market was booming, but by early 2020 it was in almost full shutdown with high uncertainty. 2021 was a year of insignificant progress, while 2022 brought a slow but steady recovery, expected to continue in 2023.

Valuers of all types of business must focus on income, suppliers and operational activities. For a hotel, this gives:

1. Income – What impact will a change in external economic factors have on demand in this particular segment? How will the changes affect demand?
2. Suppliers – delivery times and availability of goods and services. The Covid-19 period has particularly affected logistics, now war in the region makes it worse and more complex.
3. Operational activities – Covid morbidity affected the personnel working in the hotel, limiting working hours and productivity. In Georgia, hotels were unable to recoup their skilled workforce after the temporary closure.

Table 1. Performance indicators of 5* hotel in Batumi, Georgia, seaside city.

Hotel	2019	2020	2021
Occupancy rate%	67%	21%	30%
Average room Rate USD	\$ 101.91	\$ 76.43	\$ 80.00
Number of available rooms (year)	61320	61320	61320
RevPAR (revenue per available room), USD	\$ 68.28	\$ 16.05	\$ 24.00
Number of occupied rooms (year)	41084	12877	18396
Room income (ex VAT)	\$ 4,186,911	\$ 984,204	\$ 1,471,680

2020 and early 2021 turned out better than expected: a number of hotels in Georgia were converted to “covid hotels” and received income from the government; others took special measures to maximise revenue, namely:

- ▶ Special prices for regular customers
- ▶ Creation of corporate packages
- ▶ Discounts for long-term bookings
- ▶ Corporate events
- ▶ Special offers for international organisations, etc.

The record high occupancy rates expected for 2022 have no correlation with high incomes, being solely due to the influx of war refugees.

To gauge the hotel's future income streams we used OECD¹, International Monetary Fund², and UNWTO (The World Tourism Organization) projections. At end 2020 they indicated that recovery of the hospitality sector was expected for 2023, but at end 2021 it was shifted to 2024.

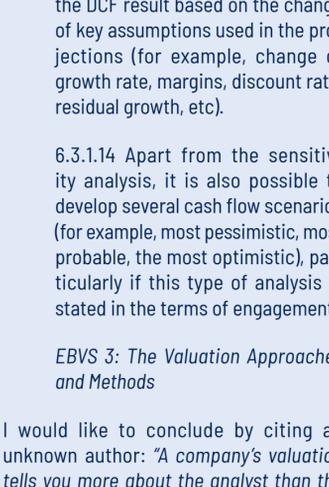
The second factor affecting the company's value is the risks associated with cash flow. In this model we used the CAPM (capital assets pricing model) component of WACC (weighted average cost of capital) to derive the cost of equity capital.

The risk-free rate and equity risk premium (ERP) are key inputs used to calculate the cost of equity capital in the context of the CAPM and other models used to develop discount rates.

In Georgia we do not have high maturity Government bonds and as a rule the risk-free rate is calculated as a sum of a risk-free rate of AA rate countries and country risk.

Before 2020 valuers were using so-called “spot” risk-free rates as a component of their cost of equity capital estimates, but the Covid-19 crisis caused us to question whether this approach was still reliable.

The figure below shows high volatility of the Daily Treasury Long-Term Rate:



Source: <http://www.treasury.gov/resource-center/data-chart-center/interest-rates/Pages/TextView.aspx?data=yield&year=2023>

The reason for the sharp decline of risk-free rates in year 2020 was the response of major central banks to the crisis and the introduction of one of the most prominent forms of unconventional monetary policy – quantitative easing (“QE”) – and the significant expansion of central bank balance sheets by which central banks try to bring consumer price inflation up to their respective target levels (typically around 2%). After December 2021 major central banks continued to raise interest rates to tame high inflation which reached record high levels in some countries (70-year record high for Germany). There is a hope that interest rates will stop rising in 2023, as long term inflation expectations are 2,4% for the U.S. and 2,8% for Germany as of January 1, 2023.

“Before 2020 valuers were using so-called “spot” risk-free rates as a component of their cost of equity capital estimates, but the Covid-19 crisis caused us to question whether this approach was still reliable.”

Total Assets Held by Major Central Banks Over Time

Source: Capital IQ, FRED Economic Data, Bank of England, Bank of Japan and European Central Bank.

To avoid significant calculation inaccuracies, we rely on the recommendations published by Krall (former Duff & Phelps) to use the so-called normalised risk-free rate. Current recommendations are to set the rate at 3.5%³.

Another risk-free rate component, Georgia country risk, also changed drastically: from 2.91% at end 2020 to 5.19% at end 2022⁴. Interestingly, in 2008 when Russian tanks were just 30 km from the capital Tbilisi, the county risk did not change a bit, while the invasion of Ukraine in 2014 caused a sharp rise in Georgia country risk, meaning that our country is too small to influence anything, but a change in the regional equilibrium affects it a lot.

The third component of CAPM is ERP which ranges from 3.5% to 6%. Kroll's current recommendation is 6% (see table below).

Date	Risk-free rate (Rf)	Rf (%)	Kroll Recommended U.S. ERP (%)	What Changed
October 18, 2022 – UNTIL FURTHER NOTICE*	Normalised 20-year U.S. Treasury yield	3.50%	6	ERP
June 16, 2022 – October 17, 2022	Normalised 20-year U.S. Treasury yield	3.50%	5.5	RF
April 7, 2022 – June 15, 2022	Normalised 20-year U.S. Treasury yield*	3.00%	5.5	RF
December 7, 2019 – April 6, 2020	Normalised 20-year U.S. Treasury yield	2.50%	5.5	ERP

Source: <https://www.kroll.com/-/media/cost-of-capital/kroll-us-erp-rf-table-2022.pdf>

Kroll recommends using the spot 20-year U.S. Treasury yield as the proxy for the risk-free rate, if the prevailing yield as of the valuation date is higher than our recommended U.S. normalised risk-free rate of 3.5%.

As an example, in the Eurozone:

Date	Normalised risk-free rate - Germany	Eurozone equity Risk Premium Recommendation
December 2019	2%	4.5% to 5.0%
March 2020	2%	5.5% to 6.0%
April 2021	2%	5.5% to 6.0%
November 2021	1.50%	5.5% to 6.0%
October 2022	Higher of 3.0% or spot*	5.5% to 6.0%
January 2023	Higher of 3.0% or spot*	5.5% to 6.0%

* Spot 15 year German government bond yield as the proxy for the risk-free rate, if it is higher than the recommended normalised risk-free rate.

Another component of CAPM, beta, shows the following dynamics, which are perfectly logical: during Covid beta exceeded the average market level, returning to normal in 2023:

Source: https://pages.stern.nyu.edu/~adamodar/News_Home_Page/data.html

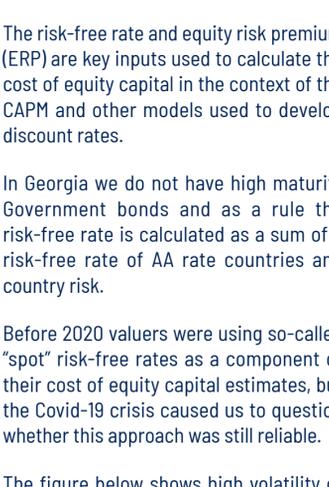
Georgian hotel industry WACC calculations showed an around 1% WACC increase from 2019 to 2020, the figure remaining almost the same in 2021, but compared with 2019 in 2023 the value increased by a stunning 3% (WACC after tax in USD). This will have major impact on the value of the company.

“Georgian hotel industry WACC calculations showed an around 1% WACC increase from 2019 to 2020, the figure remaining almost the same in 2021, but compared with 2019 in 2023 the value increased by a stunning 3% (WACC after tax in USD). This will have major impact on the value of the company.”

For the valuation as at 31.12.2020, a model for calculating the company's net cash flow for the next period was developed, by which the pre-crisis level of hotel occupancy and the pre-crisis average price of a room were projected to be reached in 2023. But in the 31.12.2021 model, those levels were moved forward by a year. Many questions remain concerning development of future cash flows for the 31.12.2022 valuations: What is the prognosis of global organisations for this industry? Should we rely on the very high incomes of 2022 or is it better to normalise the forecasted 2023 cash flow; etc.

Calculations showed that the value of a five-star hotel in Batumi by the end of 2020 decreased by 23% compared to 2019, followed by recovery in 2021.

If we look at CBRE Hotel Advisory research, change in value is clearly consistent with the average trends in this area:



Source: CBRE Hotels Advisory, Transaction and Appraisal Data

“When calculating the value of a company under conditions of high uncertainty, it is advisable to use several scenarios and then weigh the results as EBVS mandates.”

My recommendations for business valuers in situations where external economic factors change dramatically:

- ▶ Attention should be given to forecasting future cash flows, which change significantly.
- ▶ Risks associated with cash flows also change significantly: one of the approaches is to use normalised risk-free rates of AA risk countries, keeping in mind that average market risk is cyclical. As for the beta coefficient, there are various sources and they should be used with a certain caution.
- ▶ When calculating the value of a company under conditions of high uncertainty, it is advisable to use several scenarios and then weigh the results as EBVS mandates:

6.3.1.13 Depending on the specific circumstances and uncertainties related to the subject business, industry and economy, the sensitivity analysis may be applied to test the DCF result based on the change of key assumptions used in the projections (for example, change of growth rate, margins, discount rate, residual growth, etc).

6.3.1.14 Apart from the sensitivity analysis, it is also possible to develop several cash flow scenarios (for example, most pessimistic, most probable, the most optimistic), particularly if this type of analysis is stated in the terms of engagement.

EBVS 3: The Valuation Approaches and Methods

I would like to conclude by citing an unknown author: *“A company's valuation tells you more about the analyst than the company”*⁶.

¹<http://www.oecd.org/coronavirus/policy-responses/rebuilding-tourism-for-the-future-covid-19-policy-responses-and-recovery-bced9859/>

²<https://www.imf.org/external/pubs/ft/ftandd/2020/12/impact-of-the-pandemic-on-tourism-behsudi.htm>

³<https://www.duffandphelps.com/insights/publications/cost-of-capital>

⁴<http://people.stern.nyu.edu/adamodar/pc/datasets/ctryprem.xls>

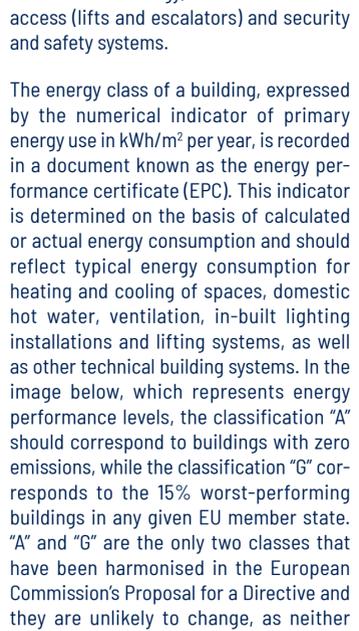
⁵Mark Kantšukov (Estonia), Preet Sander (Estonia), Value in the eye of the beholder: a survey of valuation practices of Estonian financial professionals



PLANT MACHINERY & EQUIPMENT VALUATION

#05

Green Deal decarbonisation of the building stock rides on technical building systems



Ana Caldeira Martins

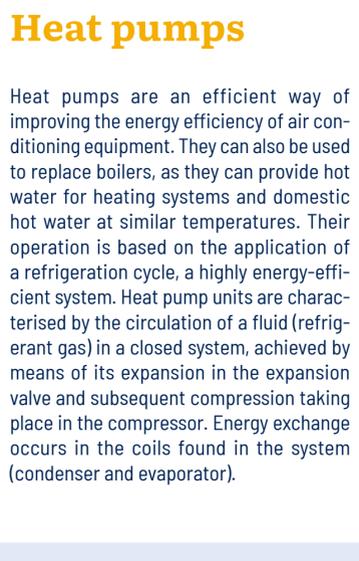
The European Green Deal conjures up a picture of frenetic building shell renovation activity, but in fact the Deal won't get done unless there's also a step change in deployment of modern technical building systems. Ana Caldeira Martins explains how the Green Deal's building legislation provides for this and helps valuers distinguish what works best.

Buildings account for 36% of EU GHG emissions and 40% of final energy consumption, so the European Green Deal depends more than anything else on their decarbonisation. Construction and renovation of the building shell are of course determinant, but no less so than the buildings' technical installations.

One of the pillars of the European Green Deal, the EU Energy Performance of Buildings Directive (EPBD), sets out the minimum requirements applicable to the design and renovation of buildings and presents the method of determining their energy performance.

In buildings, the architecture and construction materials are decisive in determining the energy needs for thermal comfort and lighting. The HVAC and lighting installations in buildings are designed to meet these needs. There are also other installations that consume energy, such as mechanical access (lifts and escalators) and security and safety systems.

The energy class of a building, expressed by the numerical indicator of primary energy use in kWh/m² per year, is recorded in a document known as the energy performance certificate (EPC). This indicator is determined on the basis of calculated or actual energy consumption and should reflect typical energy consumption for heating and cooling of spaces, domestic hot water, ventilation, in-built lighting installations and lifting systems, as well as other technical building systems. In the image below, which represents energy performance levels, the classification "A" should correspond to buildings with zero emissions, while the classification "G" corresponds to the 15% worst-performing buildings in any given EU member state. "A" and "G" are the only two classes that have been harmonised in the European Commission's Proposal for a Directive and they are unlikely to change, as neither the Council of Ministers nor the European Parliament have amended this aspect.



Levels of energy performance
Source: REHVA, Federation of European Heating, Ventilation and Air Conditioning Associations

The technical installation measures imposed by the Directive include:

- ▶ Solar rooftop installation for all buildings except existing residential;
- ▶ Air-conditioning, ventilation and water heating systems should preferably be supported by alternative energy sources and, in the case of support from direct systems, by systems with no direct greenhouse gas emissions (i.e. which do not emit those gases on site);
- ▶ In-built lighting systems must meet the minimum illumination and power density requirements;
- ▶ Mechanical access systems such as lifts and escalators must meet minimum energy efficiency requirements;
- ▶ Building automation and control systems (BACS) must ensure technical management of the operation of all the building's equipment, including rationalisation of energy use, through incorporating building digitisation solutions;
- ▶ Buildings must have electric vehicle charging system infrastructure.

By way of example, the two tables below, taken from the Portuguese transposition of the previous EPBD, show the minimum energy efficiency requirements for BACS and mechanical access systems.

Minimum energy efficiency requirements for BACS systems, according to Standard EN 15232

Date requirement applied	Energy efficiency class
Entry into force of this decree	Class B
As of 1 January 2025	Class A

Minimum energy efficiency requirements for BACS systems, according to Standard EN 15232

Type of equipment	Minimum energy efficiency class	Methodology
Lifts	B	ISO 25745-2
Hydraulic lifts	C	ISO 25745-2
Escalators and moving walkways	A	ISO 25745-3

Technology comes alongside and very often ahead of legislation, offering various solutions to achieve these objectives.

“Solar photovoltaic panels stand out amongst the available equipment for passive energy production.”

Energy generation

Solar photovoltaic panels stand out amongst the available equipment for passive energy production. Energy is produced by conversion of the solar energy hitting the photovoltaic panel composed of semiconductor materials, by means of the photoelectric effect on the photovoltaic cells. The electricity produced by the solar panel generates direct current (DC) which is converted into alternating current (AC) through an inverter. In this way, the electricity may be used by domestic appliances, whether consumed directly or injected into the grid, or be stored in solar batteries for later consumption. There are different types of photovoltaic cells, depending on the nature and characteristics of the materials used. The most widespread technology currently on the market relies on crystalline silicon, which in turn is subdivided into poly-crystalline and mono-crystalline. There are also other types of solar panels, such as thin-film panels, which can easily be incorporated into other components, such as tiles, glass, stonework, etc. Depending on the material used, we may find thin-film panels of amorphous silicon (a-Si), cadmium telluride (CdTe), copper, indium, gallium and selenium (GIS/ClGS) or organic photovoltaic cells (OPC). Whatever the solution, the aim will be greater production of passive energy incorporated in the design and orientation of the building.

Passive HVAC systems

Passive heating and/or cooling systems use alternative energy, including equipment powered by geothermal energy, free energy from the ground, aerothermal energy drawing on existing thermal energy in the air, or solar energy based on using solar radiation to heat water. The equipment available on the market is briefly described below:

- ▶ **Solar thermal collectors for heating and domestic hot water (DHW):** These systems comprise the solar panel, the hot water accumulation tank, the pumping system and accessories. The operation of this system is based on solar radiation which, on hitting the solar collector, heats the solar fluid which will heat the water inside the tank. This system may be supported by active heating systems such as heat pumps;
- ▶ **Geothermal energy systems:** Heat pumps for heating, cooling and domestic hot water using geothermal energy. The geothermal energy systems consist of capturing free energy from the ground, benefiting from a constant temperature of approximately 16°C throughout the year;
- ▶ **Aerothermal energy systems:** Heat pumps for heating, cooling and DHW using aerothermal energy. Aerothermal energy is a renewable energy which draws thermal energy from the air and transfers it inside the home to provide heating, cooling and domestic hot water, depending on the level of comfort needed in the home.

Heat pumps

Heat pumps are an efficient way of improving the energy efficiency of air conditioning equipment. They can also be used to replace boilers, as they can provide hot water for heating systems and domestic hot water at similar temperatures. Their operation is based on the application of a refrigeration cycle, a highly energy-efficient system. Heat pump units are characterised by the circulation of a fluid (refrigerant gas) in a closed system, achieved by means of its expansion in the expansion valve and subsequent compression taking place in the compressor. Energy exchange occurs in the coils found in the system (condenser and evaporator).

In the evaporator there is an exchange of energy between the refrigerant and the environment through the process of heat transfer by cooling the space. In the condensing the process is the inverse, transferring heat to the environment and heating it. In the image on the left we can see the representation of the described refrigerating cycle.

The energy efficiency of a heat pump unit is defined by its ability to generate the same amount of energy for cooling or heating with fewer natural resources.

The terms COP (Coefficient of Performance) and EER (Energy Efficiency Ratio) define the heating and cooling efficiency of heat pumps. Their result is determined by the ratio of heating or cooling provided by a heat pump unit to the amount of electricity supplied to generate it.

$$COP = \frac{\text{Heating capacity (kW)}}{\text{Consumed energy (kW)}}$$

$$= \frac{4 \text{ (kW)}}{1 \text{ (kW)}} = 4$$

$$EER = \frac{\text{Cooling capacity (kW)}}{\text{Consumed energy (kW)}}$$

$$= \frac{4 \text{ (kW)}}{1 \text{ (kW)}} = 4$$

That is, if a heat pump delivers 4 kW of heat with 1 kW of electricity supplied, its COP is 4.0. Similarly, if a heat pump delivers 4kW of cooling with 1 kW of electricity supplied, its EER is also 4.0.

The higher the COP and EER, the higher the energy efficiency of the equipment.

Apart from very high energy efficiency, heat pumps also have the advantage of not emitting greenhouse gases on site.

“The energy efficiency of a heat pump unit is defined by its ability to generate the same amount of energy for cooling or heating with fewer natural resources.”

Building automation and control systems – BACS

In larger buildings, BACS are a priority system for ensuring energy efficiency by rationalising energy consumption. BACS encompass all the equipment, software and engineering services contributing to the economical, safe, and energy-efficient operation of technical building systems.

The automation system must ensure:

- ▶ continuous, comparative monitoring, recording and analysis of buildings' energy consumption and energy efficiency, so as to obtain information on actual or potential energy performance;
- ▶ communication and interaction between all the technical systems.

By implementing these measures, we can achieve zero consumption, or ZEB (zero energy building) in new buildings and radical improvements in existing ones.

How to achieve zero energy consumption or, even better, make the building a net energy producer? By using passive systems for producing electricity and storing the energy produced. In cases where passive HVAC systems are not sufficient for the thermal needs of the building, heat pump units can be used, characterised by high energy efficiency and zero GHG emissions on site. For the remaining technical installations, the same actions should be undertaken, considering their greater efficiency and lower energy consumption.

But there may be limitations to the production of energy in a building determined by its architecture and available solar exposure area, among others. One increasingly popular solution in the EU is Renewable Energy Communities (REC's): the sharing of clean energy by a group of citizens and public and private institutions at advantageous costs with significant reduction of GHG emissions.

The paradigm shift we are seeing will undoubtedly have a major impact on the building sector, with new architectural and construction solutions and technical installations very different from those of today.

Similarly, asset valuation must support and meet the needs of the various stakeholders with assurance and the ability to understand the consequences of the ongoing changes.

“How to achieve zero energy consumption or, even better, make the building a net energy producer? By using passive systems for producing electricity and storing the energy produced.”

¹That is why the Directive allows for exemption from the rooftop solar installation requirement for buildings with low solar energy potential.

²Promoted by the revised Renewable Energy Directive

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