Journal of Sustainable Real Estate

ISSN: 1949-8276 (Print) 1949-8284 (Online) Journal homepage: www.tandfonline.com/journals/rsre20

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To cite this article: Michaël Peeters, Ali Khan, Daan Schraven & Hilde Remøy (2026) Impact of EU Sustainability Regulations on Highest and Best Use Valuation in Real Estate, Journal of Sustainable Real Estate, 18:1, 2651563, DOI: 10.1080/19498276.2026.2651563

To link to this article: https://doi.org/10.1080/19498276.2026.2651563

Published online: 01 May 2026.

JOURNAL OF SUSTAINABLE REAL ESTATE
2026, VOL. 18, NO. 1, 2651563
https://doi.org/10.1080/19498276.2026.2651563

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Impact of EU Sustainability Regulations on Highest and Best Use Valuation in Real Estate

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ABSTRACT

This paper investigates how new EU sustainability regulations, specifically the EU Taxonomy, Corporate Sustainability Reporting Directive (CSRD), Sustainable Finance Disclosure Regulation (SFDR), and Corporate Sustainability Due Diligence Directive (CSDDD), are reshaping highest and best use (HBU) valuation in real estate. A literature review on HBU, sustainable real estate valuation, and real options theory is conducted. A theoretical model is developed for HBU analysis under regulatory constraints, with formal stochastic calculus derivations illustrating how real options can be valued. Investors must account for regulatory uncertainty and technological change, which elevate the value of flexible strategies. A real options approach enables the quantification of the value of waiting to retrofit, expanding green features, switching asset use, or abandoning projects in response to stochastic factors, such as energy prices or carbon costs. This study integrates the impacts of EU sustainability policy with real estate valuation principles and real options financial theory. A mathematical derivation for real estate valuation under regulatory uncertainty is presented. The results inform appraisers, investors, and policymakers on aligning valuation methods with sustainability objectives.

ARTICLE HISTORY
Received 20 August 2025
Revised 20 January 2026
Accepted 23 March 2026

KEYWORDS
Real options; sustainability regulation; valuation; highest and best use

Introduction

The real estate sector is at the forefront of the sustainability transition, as buildings account for roughly 40% of CO_2 emissions in the EU. In response, the European Green Deal and related policies aim to cut emissions by 55% by 2030 and achieve climate neutrality by 2050 (Bäckstrand, 2022). A series of new EU regulations has been introduced to steer capital and corporate behavior toward these goals. The EU Taxonomy establishes criteria for sustainable economic activities, including strict energy efficiency standards for real estate. The Corporate Sustainability Reporting Directive (CSRD) mandates comprehensive environmental, social, and governance (ESG) reporting using a double materiality lens, meaning that companies must report both how sustainability issues affect them financially and how their activities impact the environment. The Sustainable Finance Disclosure Regulation (SFDR) requires asset managers to disclose sustainability characteristics of their funds, effectively channeling investment toward greener assets. Meanwhile, the proposed, but not yet implemented, Corporate Sustainability Due Diligence Directive (CSDDD) will require companies to conduct due diligence to identify and mitigate environmental and human rights impacts in their operations and supply chains. Collectively, these regulations embed sustainability considerations into financial decision-making and asset management on an unprecedented scale.

In real estate valuation practice, these policy shifts necessitate reexamining the traditional concept of highest and best use (HBU). HBU is defined as the reasonably probable and legal use of a property that is physically possible, financially feasible, and maximally productive (i.e., yields the highest value) (Walacik et al., 2020). Historically, HBU analysis has focused on factors such as zoning (legal permissibility), site/building constraints (physical feasibility), and profitability under market conditions (financial feasibility and maximum productivity). Sustainability was often a secondary consideration, addressed implicitly through operating cost savings or risk premiums if at all (Epstein, 2018; Mills, 2015b). However, with the

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advent of binding climate regulations and changing market preferences, sustainability attributes are now material to each of the HBU criteria. For instance, energy performance requirements can determine the legal permissibility (e.g., minimum building standards), physical feasibility (e.g., whether a retrofit is physically viable or continued use is possible) and, indeed, financial feasibility (through impacts on rents, costs, and risk).

Early evidence of this shift is evident in professional guidance, as the International Valuation Standards Council (IVSC) notes that ESG factors should be considered for tangible assets, as they impact owners, operators, and the physical asset itself (Ghosn et al., 2024). ESG elements can influence HBU's first three tests (possible, permissible, feasible) and ultimately the long-term productivity of a use. For example, a proposed property use that cannot meet upcoming energy efficiency mandates may fail the "legally permissible" test even if it is currently allowed, or it may be deemed financially infeasible once future retrofit costs or penalties are factored in. Conversely, a sustainable use (such as a net-zero carbon building or a green-certified development) might unlock incentives or investor demand that enhance its financial feasibility and value.

At the same time, the market's understanding of "green value" has matured. Over the past decade, numerous studies (Brounen et al., 2020; Brown & Watkins, 2016; McCord et al., 2024) have documented green premiums (i.e., higher sale or rental values for sustainable buildings) and brown discounts (i.e., value penalties for inefficient, high-emission properties) in real estate markets. For instance, certified green office buildings have been found to achieve rents on average 5% higher (and up to 20% higher in some cases) than comparable conventional buildings (Jayakody & Vaz, 2023; Zhu et al., 2018). They also tend to enjoy higher occupancy and lower vacancy (often 1%–2% vacancy for green buildings versus higher rates for noncertified peers) (Rahman et al., 2017). Sales price premiums for sustainable buildings have been documented in the range of approximately 0% to 40%, with an average of around 10% to 15% (Blake, 2023). On the other hand, inefficient buildings may suffer value erosion as investors price in future upgrade costs or regulatory noncompliance. These empirical trends underscore that sustainability features are not just moral or compliance considerations; they have quantifiable economic impacts that must be reflected in valuation.

This paper addresses the intersection of these developments by asking: How do EU sustainability regulations impact HBU valuation in real estate? We explore this through several connected lenses. First, we identify the additional parameters that appraisers and analysts need to consider in valuation methodologies due to sustainability regulations. Second, we examine the impact on cash flows, specifically, how "green" or "brown" performance affects rental income, operating expenses, upgrade or adaptation costs, and other capital expenditure (CAPEX) needs, financing, and liquidity. Third, we discuss uncertainty and risk, including regulatory uncertainty, technological change, and shifting market preferences, which introduce new risks to valuation, in the Uncertainty and Risk Considerations section. Finally, we consider the long-term perspective of the 2050 EU net-zero transition goals and how alignment (or misalignment) with that trajectory can alter an asset's valuation and optimal use.

To develop a rigorous analytical framework for these issues, we employ real options theory. Real options analysis provides a tool to value managerial flexibility under uncertainty, treating investment decisions (such as retrofitting a building or repurposing a property) analogously to financial options. We extend real options modeling to incorporate sustainability-related choices, for example, the option to delay an investment until clearer regulations or cheaper technology (deferment), the option to expand a project to include sustainable features (expansion), the option to switch a building's use or systems to a more sustainable alternative (switching), or the option to abandon or redevelop an asset that becomes untenable (abandonment). We present a formal derivation using stochastic calculus, illustrating how uncertain factors such as energy prices or carbon costs can be modeled as stochastic processes and how the optimal timing of a retrofit or other intervention can be formulated as an optimal stopping problem.

The research methodology combines a structured literature review of academic and industry sources with a theoretical development of valuation models. We draw on literature from valuation (including appraisal standards and empirical studies on sustainability and value) and finance/economics (real options applications to real estate and energy efficiency investments). Throughout the discussion, we integrate case studies and examples to ground the concepts, such as regulatory case examples (e.g., the Netherlands' energy label mandate for offices) and scenario analyses (e.g., projecting a building's compliance pathway using tools such as Carbon Risk Real Estate Monitor (CRREM).

In doing so, this paper contributes to both theory and practice. For theory, it bridges the gap between sustainable finance regulations and real estate economics, proposing a quantitative framework for HBU under climate transition risk. For practice, it provides guidance to valuers and investors on how to adjust valuation models to incorporate sustainability factors and how to apply real options thinking to guide investment decisions under uncertainty. The findings highlight that the HBU in the 2020s is no longer a static concept tied solely to current market demand; it must be a dynamic, forward-looking determination that accounts for a property's resilience or vulnerability in a decarbonizing world.

Literature Review

Sustainability in Real Estate Valuation

Traditional real estate valuation relies on three primary approaches: the cost approach (estimating value based on replacement or reproduction cost minus depreciation), the sales comparison approach (comparing the subject property to similar, recently sold properties), and the income approach (valuing property based on its income-generating potential) (Pagourtzi et al., 2003). The income approach, particularly for investment properties, often employs discounted cash flow (DCF) analysis, which projects future cash flows and discounts them to present value using an appropriate discount rate (Leskinen et al., 2020). Net present value (NPV) is a core output of DCF, representing the sum of discounted future cash inflows and outflows, and serves as a key decision metric for investment viability. The principle of HBU seeks to identify the property use that maximizes value. DCF and NPV are fundamental to HBU analysis because they quantify and compare the present value of alternative uses, ensuring that the selected use is the one that delivers the greatest economic return.

New approaches to sustainable real estate valuation increasingly integrate ESG factors, green building certifications, and life-cycle considerations into traditional valuation models (Leskinen et al., 2020; Marques et al., 2024). These methods recognize the financial benefits of sustainability by explicitly incorporating them into discounted cash flow analyses and market comparisons. In recent publications (Gil-Ozoudeh et al., 2024; Kempeneer et al., 2021; Leskinen et al., 2020; Runde & Thoyre, 2010; Valero, 2025; Warren-Myers, 2022), multi-criteria decision-making frameworks, user-centered smart technologies, and enhanced data collection on sustainability attributes are also being adopted to better capture the value added by sustainable features. Furthermore, literature such as Durica et al. (2018) and Smit (2025) also suggests incorporating real options to improve corporate sustainability appraisal. Despite challenges including limited standardized data and evolving regulations, these innovations aim to ensure that property values more accurately reflect both the economic and societal benefits of sustainable real estate practices.

Recent literature also highlights a steady increase in the adoption of green building certifications across major European office markets. In Italy, for instance, nearly zero energy buildings account for approximately 15.86% of new construction, reflecting the impact of EU directives mandating higher energy performance standards for new and renovated buildings (Massimo et al., 2022). Across the EU, about 35% of buildings are more than 50 years old, and nearly 75% of the building stock is energy-inefficient, with a renovation rate of just 1% per year, indicating both the challenge and the potential for further growth in the green building segment (Katafygiotou et al., 2023). However, comprehensive data combining all major certification schemes (LEED, BREEAM, DGNB, HQE) are still limited, and the literature calls for broader studies to capture the full extent of green building penetration across the EU (Gluszak et al., 2021).

Integration of ESG Factors

The inclusion of environmental and social criteria in property valuation has evolved from a niche to a mainstream approach in recent years. Early valuation practices for "green" buildings identified unique benefits, such as lower energy and water costs (Dwaikat & Ali, 2016), which could improve net operating income. However, appraisers struggled to find direct market evidence to quantify a value premium (Mills, 2015a). The paucity of comparable transactions in each local market for green-certified buildings limited traditional valuation approaches (sales comparison). As a result, valuers often relied on the income approach (capitalizing on higher expected net income or lower risk) or the cost approach (considering replacement cost with depreciation adjustments) to capture the value of green buildings. Over time, as sustainable building certifications (e.g., LEED, BREEAM) have become more prevalent, more transactional data have emerged, enabling empirical analysis of the "green premium." Studies have consistently found that sustainability certifications and high energy performance ratings correlate with higher rents and values (Dwaikat & Ali, 2016; Jayakody &

Vaz, 2023; Leskinen et al., 2020; Marques et al., 2024; McCord et al., 2020; Mills, 2015a; Rahman et al., 2017). For example, a 2024 review by Van Overbeek (van Overbeek et al., 2024) compiled evidence that certified buildings enjoy rental premiums averaging 10.3% and sale price premiums ranging from 5.1% to 12.6%. These premiums are attributed to factors such as operational cost savings, improved tenant demand, and lower risk perceptions for sustainable assets (Marques et al., 2024). Importantly, green buildings also tend to have higher occupancy and lower default risk. Vacancy rates for energy-efficient properties are significantly lower (often near 1%–2%) compared to those for less-efficient buildings, and some banks have reported lower mortgage default rates on energy-efficient homes, suggesting improved credit performance (Bell et al., 2023; Billio et al., 2022; Sanderford et al., 2015).

Risk and Obsolescence

On the other hand, properties with poor sustainability performance are increasingly viewed as riskier investments. The concept of brown discount reflects that such properties may trade at a discount or higher cap rate (lower valuation) to compensate for future costs or risks. These can include higher utility expenses, potential carbon taxes or fines, and the risk of early obsolescence. The term "stranded asset" has entered the real estate vocabulary to describe a building that becomes unusable or economically nonviable before the end of its expected life, due to sustainability factors (Ferentinos et al., 2023; Jagarwal et al., 2024; Stone & Kinsella, 2023). This can occur if the building fails to meet future energy efficiency standards or if market preferences shift significantly, causing tenants/investors to shun the property. According to the CRREM initiative, stranded assets in the built environment are those that will face early obsolescence due to not meeting future regulatory requirements or market expectations for climate performance, thereby becoming less marketable and requiring costly retrofits (Hirsch et al., 2023). This risk has become tangible as governments signal stricter building standards; for example, the EU's Energy Performance of Buildings Directive (EPBD) proposals include Minimum Energy Performance Standards (MEPS) that could progressively require existing buildings to upgrade their energy labels or face usage restrictions. Empirical research by risk analysts and academics (e.g., the CRREM project and various bank studies) has begun to quantify "carbon value at risk," the percentage of an asset's value that could be lost due to carbon transition factors if no mitigating action is taken (Hirsch et al., 2019).

Valuation Practice Developments

Recognizing these trends, valuation professional bodies have begun issuing guidance. The Royal Institution of Chartered Surveyors and IVSC have published guidance notes on considering sustainability. They encourage valuers to collect relevant data (such as energy ratings and retrofit costs) and incorporate it into valuations, even if indirectly through yield adjustments or risk premiums. A risk-based approach is often suggested, where sustainability affects the discount rate or capitalization rate applied. A building with high future retrofit risk might warrant a higher capitalization rate (lower value) to reflect that risk. Conversely, a property with strong green credentials may see a lower cap rate (higher value) due to perceived lower risk and higher future liquidity. Indeed, a study by the UNEP Finance Initiative noted that green buildings tend to command premium rents and sell faster and at higher prices, making them inherently less-risky investments (Leskinen et al., 2020). In markets where sustainability is becoming a norm, what was once a "green premium" may evolve into an expectation, with inefficient buildings facing a "brown penalty" if they fail to meet market standards (Marques et al., 2024).

EU Sustainability Regulations Affecting Real Estate

EU Taxonomy

The EU Taxonomy is a classification system defining which economic activities are environmentally sustainable. Real estate activities are explicitly covered, with technical screening criteria set for the construction of new buildings, building renovation, and acquisition/ownership of buildings. To be Taxonomy-aligned for climate change mitigation, new constructions must exceed current energy efficiency requirements (e.g. at least 10% lower primary energy demand than mandated for nearly zero-energy buildings). Renovations must meet the standards of major upgrades as defined in the EPBD, typically implying a 30% energy improvement or compliance with local "major renovation" codes. Perhaps most significantly for existing assets, the Taxonomy states that the acquisition and ownership of buildings constructed before 2021 can qualify as sustainable only if the building has an Energy Performance Certificate (EPC) rating of at least Class A or is among the top 15% most energy-efficient buildings in its region. This effectively draws a line in the sand in terms of asset performance: Properties below that threshold would not be considered sustainable investments under the Taxonomy framework. In practice, this influences investor demand and access to capital. Assets that are Taxonomy-aligned can attract green bonds, green loans, or funds targeting sustainable investments, often at preferable interest rates or terms. By contrast, properties that fall outside these criteria may face higher financing costs or be excluded from specific investment portfolios. The Taxonomy also includes "Do No Significant Harm" criteria and minimum social safeguards that could affect real estate (e.g., new construction must not harm biodiversity or water resources). This adds further layers—beyond pure energy efficiency—that an HBU analysis may need to consider (e.g., a development plan might be technically feasible, but if it violates environmental safeguards, it would not meet sustainability criteria and could face permitting or financing hurdles).

Corporate Sustainability Reporting Directive

CSRD greatly expands the scope and detail of mandatory sustainability reporting for companies in the EU. Real estate companies meeting size thresholds (which many do, given the sector's high asset values and revenues) are required to disclose extensive ESG data, including climate risks, greenhouse gas (GHG) emissions, energy consumption, and building performance metrics. The CSRD introduces double materiality, meaning that firms must report how sustainability issues impact them financially and how the firm impacts society and the environment. For real estate owners, this means reporting not only on, for example, flood risk to their properties (financial impact) but also on the energy efficiency and carbon footprint of their portfolio (environmental impact). The implication for valuation is an increase in transparency and accountability. As Deloitte observes, the CSRD will be a "game changer" that forces real estate organizations to align their sustainability reporting with financial reporting, thereby making ESG performance (or underperformance) visible to investors and lenders (Duijzer et al., 2022). If a company's portfolio has many assets that are energy-inefficient or not aligned with climate targets, CSRD disclosures will highlight that, potentially affecting the company's stock performance or cost of capital. In turn, individual asset valuations might be influenced as management responds, for example, by accelerating retrofits to improve reported metrics. Moreover, CSRD requires reporting on forward-looking targets (such as emissions-reduction plans), which encourages firms to create long-term strategies for their real estate assets. An asset that does not align with a company's 2030 or 2040 climate targets may be earmarked for disposal or improvement, which can impact its current value (Duijzer et al., 2022). In summary, CSRD does not directly mandate specific building improvements, but it highlights sustainability performance, thereby reinforcing market pressures for assets to meet sustainability criteria.

Sustainable Finance Disclosure Regulation

SFDR applies at the fund/investment product level, requiring asset managers to classify and disclose how sustainability is integrated into their portfolios. Funds labeled Article 8 ("light green") promote environmental or social characteristics, while Article 9 ("dark green") funds have sustainable investment as their core objective. For real estate funds, SFDR has significant implications for asset selection. Guidance indicates that an Article 9 real estate fund may need 100% of its assets to qualify as sustainable investments at the time of acquisition (Scheitza & Busch, 2024). In practice, this likely means that such funds will only invest in buildings that are green-certified or meet high energy performance standards and align with the EU Taxonomy. This creates a segmentation in the market: The most sustainable assets are pursued by Article 8/9 funds (which now represent a significant share of European AUM), whereas less sustainable assets may only be acquired by Article 6 funds (with no sustainability focus) or opportunistic investors. The result can be pricing disparities: "Green" assets enjoy strong demand and liquidity, while "brown" assets face a thinner buyer pool and possibly a liquidity discount (Scheitza & Busch, 2024).

Additionally, SFDR's required disclosures (Principal Adverse Impact indicators, etc.) mean that even Article 8 funds must report on aspects such as GHG emissions and the energy efficiency of their buildings. If a fund holds assets with poor ratings, it must disclose high–adverse impact metrics, which is a reputational and potentially financial drawback. This incentivizes funds to either upgrade those assets or remove them. An INREV study noted that some institutional investors, when confronted with legacy portfolios that do not meet Article 8/9 criteria, might prefer to dispose of noncompliant assets rather than invest in improvements, especially if the assets are in markets where retrofitting is difficult (INREV, 2023). While such disposal might resolve the fund's classification issue, it could lead to broader market effects:

many “brown” assets on sale with few willing buyers, further depressing their values. From a valuation perspective, SFDR therefore injects a new kind of regulatory obsolescence risk: Even if a building is physically fine and generating cash today, if it cannot be brought to a sustainable standard, it may not find buyers among the majority of institutional investors soon. HBU analyses may need to account for this by considering only uses that can meet sustainability thresholds as truly viable.

Corporate Sustainability Due Diligence Directive

The CSDDD (still in the legislative process as of 2025) will require large companies to implement due diligence to identify, prevent, and mitigate adverse human rights and environmental impacts in their own operations and value chains. While this directive is broader (covering all sectors and focusing on processes), there are specific implications for real estate development and management. A real estate developer under CSDDD will need to assess the environmental impacts of a project (biodiversity loss, pollution, carbon emissions during construction, etc.) and potentially adapt plans to mitigate the significant effects. This could make specific high-impact development options (e.g., building on ecologically sensitive land or constructing buildings with excessive embodied carbon) legally and reputationally untenable, even if they were formerly permissible. In an HBU context, this adds a layer to “legal permissibility”: Beyond zoning laws, one must consider whether a use could conflict with the company’s due diligence obligations or expose the company to liability or stakeholder action. For instance, consider a site where the most profitable immediate use might be a logistics warehouse, but such a facility would generate heavy truck traffic and local air pollution. Under a strict due diligence regime, the developer might decide this poses too high a risk of breaching the environmental duty of care and instead opt for a greener use (such as a solar farm or a smaller development with mitigating measures). While such decisions ultimately depend on enforcement and stakeholder pressure, CSDDD will generally elevate the cost of nonsustainable business practices by introducing potential legal consequences for environmental harm.

Furthermore, CSDDD encourages examining the value chain, which for property investors means their supply chain (including contractors that use sustainable materials, etc.) and even tenants. It is conceivable that landlords might face pressure to ensure that tenants also operate sustainably (e.g., not using a building for a polluting activity), which could be connected to “green lease” clauses. In summary, CSDDD reinforces the notion that the HBU must be a sustainable use: Uses that cannot be executed responsibly may fail corporate governance tests, even if they pass pure market tests.

In aggregate, these EU regulations form a cohesive push toward integrating sustainability at all levels: asset classification (Taxonomy), corporate strategy and disclosure (CSRD, CSDDD), and investment flows (SFDR). The literature suggests that this regulatory landscape is accelerating the industry’s transition from viewing sustainability as a bonus or optional feature to treating it as a core determinant of value and viability (Duijzer et al., 2022; Loyens & Loeff, 2021; Tanguy, 2022). Table 1 gives a brief overview of the value implications of various sustainability regulations along with examples. Furthermore, Table 2 expands on valuation implications across the three dimensions of HBU (legal, financial, and market).

HBU Framework in Valuation

HBU is an established concept in appraisal, but it warrants revisiting through the lens of sustainability. By definition, HBU is the use of a property that meets the four criteria of being legally permissible, physically possible, financially feasible, and maximally productive (highest value). Traditionally, this analysis is conducted for both the land, as if vacant, and for the property, as improved (if a building exists), to determine whether the existing use is optimal or whether a different use (or redevelopment) would yield a higher value. The HBU analysis influences every subsequent step of the valuation, from the selection of comparable sales to the choice of capitalization rates (Beckwith, 2010; PwC Viewpoint, 2021). If, for example, a site’s HBU is determined to be a high-density residential development, the appraiser will value the land in that context, rather than in its current use (such as a warehouse), and will select comparables accordingly.

Incorporating Sustainability Factors

ESG and sustainability considerations can be integrated into HBU analysis at multiple points. According to the Appraisal Institute of Canada, ESG factors particularly affect the first three tests of HBU (legal, physical, and feasible), and the social/governance aspects may also influence the long-term productivity criterion. Let us break down the four criteria with a sustainability perspective:

Table 1. Summary of sustainability regulations and their impact on valuation.

Regulation	Jurisdiction	Scope and Deadline	Valuation Implications	Example Case
EU Taxonomy	EU-wide	Activities from 2022 onward	Stranding risk for noncompliant assets; green bond eligibility	Germany's Bayer Campus retrofit achieving Taxonomy-aligned carbon targets (2023)
CSRD	EU-wide	Large companies starting FY 2024 reports	Requires projection of cash flows under climate scenarios; affects HBU legal/financial tests	IKEA Group's 2024 sustainability report integrating climate-scenario valuations
SFDR	EU funds	Article 8/9 since 2021; periodic Principal Adverse Impact reports	Drives segmentation: Article 9 funds pursue green assets; shifts required yield assumptions	Amundi's Article 9 "Green Property" fund rebalancing portfolio toward EPC A buildings (2022)
CSDDD	EU-wide (pending)	Expected application by 2026	May alter development plans to mitigate biodiversity/human rights risks	Holcim's biodiversity impact assessments for new cement plants under emerging due diligence rules
EPC Deadlines	National (NL, UK, etc.)	NL: Min label C by Jan. 2023; UK: EPC E + by 2027	Creates finite-horizon retrofit options; induces upgrade CAPEX ahead of deadline	Dutch office block upgraded from EPC D to C in 2022 to avoid fines and increase rent premiums
CRREM	EU and UK	Pathways to 2030/2040 decarbonization	Quantifies stranding risk; feeds carbon-price scenarios into real-options models	British office fund using CRREM to flag 2030 stranding risk and adjust portfolio allocation (2023)

Table 2. Valuation impact examples of sustainability regulations across HBU dimensions.

Regulation	Legal Permissibility	Financial Feasibility	Market Profitability
EU Taxonomy	Narrows what qualifies as a "sustainable" use; nonaligned properties risk exclusion.	Green-capital access improves feasibility for aligned assets; upgrades needed for alignment.	Creates green premiums and brown discounts through investor demand shifts.
CSRD	Heightens disclosure expectations, influencing which uses firms deem acceptable.	Transparency requirements raise capital costs for poor performers and accelerate retrofit needs.	Exposes ESG underperformance, reducing demand and values for brown assets.
SFDR	Limits what institutional funds can hold, indirectly shaping viable uses.	Drives capital reallocation toward sustainable assets; increases CAPEX/financing risk for nonaligned assets.	Strengthens market segmentation, enhancing liquidity for green assets and weakening it for brown ones.
CSDDD	Imposes due-diligence duties that constrain high-impact or high-risk uses.	Adds compliance and mitigation costs, lowering feasibility for high-impact developments.	Reduces returns for impact-intensive uses while favoring lower-impact alternatives.
EPBD/National MEPS (e.g., EPC minimums)	Can render certain existing uses nonpermissible if minimum performance levels are not met.	Creates mandatory retrofit timelines that determine feasibility and timing of interventions.	Produces price penalties for noncompliant assets and competitive advantages for compliant ones.
CRREM/Carbon Pathway Tools	Signals when uses fall outside policy pathways, shaping long-term permissibility.	Quantifies stranding and retrofit costs, informing feasibility and transition timing.	Influences pricing through risk identification, differentiating future-proof and at-risk assets.

Legally Permissible. Beyond zoning, building codes, and environmental regulations, other key considerations are also important. With sustainability regulations, legal permissibility now involves meeting energy codes, emissions limits, and possibly disclosure requirements. An intended use that would result in a building not meeting minimum energy performance might not be "permissible" for long. Additionally, as regulations such as the EPBD introduce phased requirements, an HBU conclusion must consider not only current law but also impending laws. A notable real-world example is the Netherlands' mandate, effective as of 2023, that office buildings must have at least an energy label of C; otherwise, they cannot be legally used as offices. This means that for any office property below that threshold, the legally permissible use (as office) is effectively nullified unless the building is upgraded. HBU analysis for such a property might conclude that the HBU is actually to retrofit to comply or even to convert to a different use. However, it should be noted that factors such as compliance costs, possibilities of evasion, and the degree of enforcement might also be considered, as many of these regulations have a certain non-finality depending on the geopolitical context.

Physically Possible. Physical constraints include size, layout, terrain, and so on. Sustainability introduces new physical considerations, such as whether the site can accommodate solar panels or green infrastructure. Is the building physically adaptable to meet sustainability standards? Some older buildings have physical limitations that make deep energy retrofits extremely difficult, which could render the continuation of their current use physically (or functionally) impossible in the future if regulations demand such retrofits. Also, physical climate risks (which sustainability regulation indirectly forces us to consider via adaptation requirements) affect this criterion, following the adaptive reuse of existing real estate.

Financially Feasible. This is where most sustainability factors ultimately converge, since they impact costs, revenues, and risk. Sustainable features can impact rental rates (higher for green buildings), occupancy (often resulting in lower vacancy rates), operating costs (lower utilities), capital costs (higher upfront costs but potentially lower long-term costs), financing (possibly more favorable terms), and risk adjustments (e.g., a risk premium for non-green buildings). All these factors contribute to a feasibility analysis. Moreover, risk adjustments are critical: Even if a use yields high income now, if it carries high regulatory risk, it may be deemed not truly feasible in the long term. The literature suggests incorporating a risk premium or a higher discount rate for uses with poor sustainability alignment, effectively lowering their present value. In practice, the real estate market relies on established ESG indices and benchmarks to value uncertainty around sustainability reporting and regulations. The most widely used benchmarks include GRESB (Global Real Estate Sustainability Benchmark), EPRA sBPR (Sustainability Best Practices Recommendations), and global ESG indices such as S&P ESG, FTSE4Good, and MSCI ESG. Moreover, several regional as well as market-specific indices are also available and can be considered for a better representation of the local markets.

Maximally Productive (Highest Value). After the first three filters, typically several uses might be possible; the one with the highest value or profit is HBU. Sustainability affects this final selection both directly (through value impacts) and indirectly (through investor preferences). Even if a particular use appears to generate slightly higher immediate cash flow, a developer or investor might assign a lower exit value to it if they expect that, in 10 years, it will be difficult to sell or will require significant retrofit expenses. On the other hand, a sustainable use might have intangible benefits, such as brand value or meeting investor mandates, which could make it more effective in the long run. As the Appraisal Institute of Canada points out, an asset with a good ESG rating is one where environmental/social risks are well managed to preserve or maximize long-term value (Beckwith, 2010).

In summary, the traditional HBU framework remains valid; however, sustainability considerations are threaded through each criterion. The literature emphasizes the need for valuers to expand their data collection and analysis in HBU studies to include energy performance metrics, carbon costs, climate risk data, and ESG market surveys. Without such data, it is hard to support adjustments for sustainability. Nevertheless, with data, valuers can make evidence-based judgments, for example, citing studies of rental premiums to justify pro forma rent for a green building or using benchmarks such as the CRREM carbon intensity pathways to judge whether a building will incur a "stranding" penalty.

Real Options Theory in Real Estate and Sustainability

Real options theory originates from finance (e.g., Myers, 1977) and treats investment opportunities as analogous to financial options, granting the holder the right, but not the obligation, to take specific actions (invest, delay, or abandon) in the future. In real estate, classic real options applications include the option to wait (delay a development until market conditions improve), the option to stage development (phased projects), the option to change use, and the option to abandon (Quigg, 1993; Titman, 1985; Trigeorgis, 1996; Williams, 1991). More recently, researchers have applied real options to energy efficiency investments in buildings (Jose Valdez Echeverria et al., 2023; Liu et al., 2019; Yang et al., 2024). Such investments are often irreversible (Dixit & Pindyck, 2012), and their benefits are uncertain (e.g., future energy prices, occupancy). Studies find that high energy price volatility significantly increases the value of waiting (Baldoni et al., 2019; Copiello et al., 2017), making it rational to postpone the retrofit even if it has a positive NPV under deterministic assumptions. Real options analysis thus provides a framework for quantifying the premium for flexibility—essentially, the extra value gained by keeping options open under uncertainty (Lindsay, 2022; Martins et al., 2015).

Policy and Uncertainty

Real options are particularly pertinent where policy uncertainty exists (Lindsay, 2022; Yao & Pretorius, 2014)—a hallmark of today's sustainability landscape. There is uncertainty about the timing and stringency of future regulations. This uncertainty creates an "option value of waiting"; investors might delay irreversible decisions until policy paths are clearer (Lindsay, 2022). However, waiting has a cost if regulations become stricter sooner than expected or if new technology emerges and an owner misses out on early benefits. Real options modeling can help manage such uncertainty by valuing different strategies (e.g., invest now versus wait-and-see) (Cabanes et al., 2020; Guthrie, 2009a; Rocha et al., 2007).

Relevance to HBU and Flexibility

In the context of HBU, real options thinking implies that the "best" use may be one that preserves flexibility to adapt. For example, an investor might hold a property in a lower-density use today because it leaves room for future development when technology or demand improves, essentially maintaining an option to expand. Another scenario is designing a building with extra load-bearing capacity to facilitate easy conversion from office to residential use, thereby retaining a switching option in case market demand shifts. Under uncertainty and regulatory changes, such flexibility can have tangible value (Guthrie, 2009b; Lindsay, 2022). Comparing the new uses of existing real estate in different scenarios is necessary to define the highest value.

Real Options in Carbon Regulation Context

A key emerging area is how to incorporate carbon pricing and regulation uncertainty. One approach treats the future carbon price as a stochastic variable (Abadie et al., 2017). The payoff of investing in low-carbon technology is the avoidance of carbon costs. Real options models typically use partial differential equations (PDE) to find the optimal "trigger" price at which it is best to invest or switch technologies (Pringles et al., 2015). This approach can be extended to real estate, where an asset owner can wait to retrofit or can undertake a new project if carbon prices exceed a threshold. Empirical evidence shows that ignoring flexibility can lead to misestimation of value (Sheng & An, 2024); real options typically increase the valuation of projects that have high uncertainty but also the ability to adapt or wait (Dixit & Pindyck, 2012; Martins et al., 2015; Trigeorgis, 1995).

New Valuation Parameters Under Sustainability Regulations

EU sustainability regulations introduce additional parameters and metrics that must be incorporated into real estate valuation analyses. Traditional valuation, which focuses on rent, growth, and cap rates, now needs to be augmented with factors such as energy performance, carbon costs, and compliance status (Chegut et al., 2020). We identify several key parameters:

- Energy Performance and Certifications: A building's energy efficiency (often proxied by its EPC rating) is increasingly a requirement for compliance and for accessing green financing. Thus, appraisers must note the asset's rating and whether it meets current and upcoming thresholds. Some valuation models now include an explicit energy efficiency adjustment (Berry & Davidson, 2016; Bozorgi, 2015). Whether a building has a green certification (and its corresponding level) can also be an input in a comparables analysis (McCord et al., 2020).
- GHG Emissions/Carbon Cost: With the EU moving toward carbon pricing, a building's carbon footprint could translate into actual costs. Valuers should project a carbon cost line item in the cash flows for carbon-intensive assets. On the other hand, a highly efficient or net-zero building may have a "carbon credit" advantage (Weerasinghe et al., 2024). Under SFDR, funds report portfolio emissions (Martinez-Meyers et al., 2024), so an asset's carbon intensity might affect its liquidity.
- Regulatory Compliance Status: An asset's status in relation to existing and foreseeable regulatory requirements is crucial. If it fails to meet specific future standards, its current use may have a finite time horizon, and the cost to achieve compliance must be factored in. Noncompliant assets may see restricted use, lower liquidity, or outright stranding.
- Physical Climate Risk Metrics: The EU Taxonomy and CSRD also require assessing climate risks (flood risk, heat risk, etc.). This introduces potential capital outlays for adaptation. Properties with higher climate resilience may have a lower risk premium (Sayce et al., 2022).
- Social and Governance Factors: CSRD and CSDDD also touch on social/governance issues (e.g., health and safety, supply chain standards). While harder to quantify, known issues (e.g., poor air quality) can affect tenant demand and, therefore, valuation.

Impacts on Cash Flow Components

Real estate valuation methods usually consider working capital in terms of rental income, service costs, and maintenance charges as part of operational cash flows and risk management. Sustainability regulations can affect these reserves and charges by requiring higher standards for building maintenance, energy efficiency, and compliance, potentially affecting the amounts for such reserves or altering their structure to address new regulatory risks (Bergmann et al., 2020). Changing regulations and resource prices are identified as major risks that can impact cash flow models and reserve requirements for sustainable projects (Bergmann et al., 2020).

Empirical research shows that green-certified or sustainable buildings tend to achieve higher rental income and occupancy rates, lower operating expenses and vacancy risks, enhanced asset value, and reduced obsolescence risk. These factors contribute to a "green premium" in both rents and property values, as tenants and investors increasingly value sustainability features and regulatory compliance (Leskinen et al., 2020; Mangialardo et al., 2019; Marques et al., 2024; Mironiuc et al., 2021). However, the magnitude of these benefits varies by market, certification type, and local demand for sustainability (Leskinen et al., 2020; Marques et al., 2024; Mironiuc et al., 2021). In contrast, brown properties face faster obsolescence and tightening regulations, which can depress cash flows and values over time (Leskinen et al., 2020). Sustainability criteria and regulations, when applied to real estate, usually inspire measures toward resource efficiency (Bently et al., 2015; Chegut et al., 2019; Thanh Le & Warren-Myers, 2018; Warren-Myers, 2016) and affect several components of a real estate asset's cash flow:

1. *Rental Income and Occupancy:* Sustainable properties often command higher rents and achieve better occupancy rates. Tenants increasingly prefer efficient, green-certified buildings. Studies show rental premiums of 5% to 20% for green buildings (Zhu et al., 2018). Conversely, older, inefficient buildings may suffer from rising vacancy rates and rent discounts.
2. *Operating Expenses (Utilities, Maintenance, Carbon):* Efficient buildings use less energy and water, reducing operating costs and increasing net operating income (Lind & Nordlund, 2021). As carbon pricing rises, the difference in energy costs between efficient and inefficient buildings grows. Maintenance costs may also be lower in some green buildings due to the use of better-quality materials, although high-tech systems can add complexity.
3. *CAPEX and Retrofit Costs:* Sustainability regulations effectively force certain CAPEX for compliance. If a building is below the required energy standards, the cost of future retrofitting must be modeled. Appraisers can deduct a lump-sum present value or schedule it in the DCF. New green buildings may have higher initial construction costs but lower life-cycle costs.
4. *Financing Costs:* With the rise of green finance, sustainable properties can secure debt at better terms (lower interest, higher loan-to-value), reflecting their lower risk. Noncompliant assets face higher lending rates or reduced access to capital. Thus, sustainable properties may have a lower discount rate or cap rate in valuation.
5. *Exit Value and Liquidity:* Sustainability has a critical impact on terminal value. A building likely to be noncompliant or stranded by 2030 or 2035 will see a lower exit price. By contrast, a property with strong green credentials enjoys higher liquidity and a broader buyer pool. This may translate into lower exit yields.

Table 3 illustrates the impacts and potential real options of described variables on the cash flows of a real estate asset, while real options are discussed in detail later.

Uncertainty and Risk Considerations

Valuing real estate under new sustainability regulations involves significant uncertainty, particularly around regulatory developments, technological change, and market preferences.

Regulatory Uncertainty

The exact timing and stringency of future regulations are unclear. Valuers can use scenario analysis to address this, evaluating assets under different policy pathways. Alternatively, adding a regulatory risk premium to the discount rate can account for uncertainty.

Technological Change

Rapid innovation in green building technologies makes future costs and performance uncertain. This could encourage waiting for better technology or push

Table 3. Examples of real options and impacts on cash flow variables associated with sustainability regulations.

Regulatory/Market Driver	Variable	Impact Type	Description	Real Option
Energy-performance standards (EPCs), carbon pricing	Energy-cost savings	Revenue uplift /lower Operational Expense (OPEX)	Lower utility bills from efficiency measures	Underlies deferral and expansion payoffs
Green-finance incentives (SFDR Article 9), tax credits	Retrofit CAPES	Higher investment outlay	Up-front costs for sustainable upgrades (insulation, HVAC, renewables)	Strike price in call-like options
EU Emissions Trading System, national carbon taxes	Carbon-price pass-through	Revenue/cost swing	Ability to pass carbon costs to tenants or buyers	Alter the underlying volatility in all option models
EPC deadlines, EU Taxonomy noncompliance penalties	Compliance fines and penalties	Higher OPEX/write-down risk	Costs or write-downs if minimum standards (e.g., EPC) are not met by deadlines	Triggers abandonment thresholds
National renovation funds, EU Recovery facility	Green incentives and subsidies	Revenue uplift/lower CAPEX	Grants or subsidies reducing net investment or boosting cash inflows	Enhances expansion and switching project value
Market demand for ESG assets, disclosure rules (CSRD)	Occupancy/rent premiums	Revenue uplift	Higher rents (or lower vacancy) for certified/ sustainable buildings	Drives underlying payoff for switch-use options
Building codes, warranty regulations	Maintenance costs	Lower OPEX	Reduced long-term maintenance costs from higher-quality green systems	Affects the drift term in option valuation models
Circular-economy mandates, waste-reduction regulations	Salvage proceeds	Exit value	Recoverable value from materials or resale	Strike value in abandonment put options

early adoption if it might become standard. Valuers may factor in the faster depreciation of specific systems or incorporate projected declines in technology costs.

Market Preference Shifts

Demand for green buildings may continue to rise, but the pace is uncertain. Current green premiums might narrow if green becomes the norm, or brown discounts could intensify. Scenario-based projections help capture these possibilities.

Macroeconomic and Policy Interaction

Energy prices, carbon markets, and broader economic conditions all interact. If carbon taxes increase sharply, efficient buildings benefit more. Real options provide a framework for such contingencies.

Risk Mitigation Strategies

Property owners can mitigate uncertainty by designing flexible buildings, diversifying portfolios, or securing green financing. In valuation, these strategies reduce risk premiums.

Transition to Carbon Neutrality by 2050: Long-Term Implications

The EU's commitment to carbon neutrality by 2050 shapes long-term expectations. Though 2050 is beyond typical valuation horizons, it sets a direction that influences today's decisions.

Stranded Asset Timeline

By 2050, buildings must operate at net-zero. Assets that cannot feasibly be retrofitted risk stranding. Tools such as CRREM map annual carbon intensity targets, showing when a building's emissions exceed pathways. This can shorten the building's economic life if no retrofit occurs.

Investment Strategy: Retrofit Versus Redevelop

Owners weigh whether to invest early, wait for better tech, or redevelop entirely. A real options approach helps optimize timing. Delaying can preserve optionality but risks sudden regulatory action. Early action secures compliance but might incur higher costs.

Policy Trajectory and Interim Targets

Regulations will likely tighten every few years. Appraisers can model compliance costs in stages (2030, 2040, etc.). Properties with a clear path to net-zero retain value better.

Green Value Evolution

As sustainability becomes standard, today's green premium may become tomorrow's baseline. Brown discounts will be widened if buildings do not meet the expected norms. Over the long term, net-zero could become the minimum requirement.

Real Options Framework for Sustainable Real Estate Valuation

This section follows Dixit and Pindyck's seminal work. A thorough analysis can be found in textbooks, for example, *Investment Under Uncertainty* (Dixit & Pindyck, 1994).

Sustainability-Generated Real Options in Real Estate

In the context of real estate investments, the following are some simple examples of real options that could potentially manifest due to sustainability regulations Table 4:

- *Option to Defer (Timing) Figure 1:* The choice of when to undertake sustainability investments (such as the decision to retrofit a building to meet sustainability regulations). Uncertainty about future regulations and tech improvements may justify waiting, although waiting forfeits current benefits.
- *Option to Abandon:* The ability to cease operations or demolish if a building becomes nonviable. If noncompliance penalties or carbon costs become too high, abandonment might be preferable.
- *Option to Expand (or Invest in Stages):* Owners can implement a moderate retrofit now and retain the option to expand to deeper retrofits or add features later, as conditions warrant.
- *Option to Switch:* Changing a building's use (e.g., office to residential) or switching energy sources in response to market or regulatory signals. Design flexibility can significantly enhance an asset's resilience to uncertainty.

For the scope of this paper, we limit our demonstration and only illustrate modeling the option to defer in the following subsections.

Stochastic Model Setup

A typical real options approach uses a stochastic variable to represent uncertainty (Morel, 2020; Pringles et al., 2015; Sakki et al., 2022; Schachter & Mancarella, 2016), such as the energy price P. For illustration, let P follow a geometric Brownian motion:

$$dP = \mu P\ dt + \sigma P\ dW,$$

where μ is the drift, σ is the volatility, and W is a Wiener process. Building cash flow in the brown (non-retrofitted) state is a function of P, for example:

$$\pi_b(P) \ = R - \alpha - \beta P,$$

where R is rent, α other expenses, and βP the energy cost. The building's value without retrofit, $V_b(P)$, can be derived by solving a Hamilton–Jacobi–Bellman equation under risk-neutral pricing:

$$\frac{1}{2}\sigma^2 P^2 \frac{\partial^2 V_b}{\partial P^2} + \mu P \frac{\partial V_b}{\partial P} - rV_b + (R - \alpha - \beta P) = 0.$$

If the owner retrofits at cost I, the building's value switches to $V_g(P)$ with improved cash flow (lower β, possibly higher rent). The decision to retrofit is treated as an American call option on the improved state. One solves for an optimal trigger P^* at which the gain from retrofitting equals the option's remaining time value. Boundary conditions ensure continuity and smooth pasting:

$$V_b(P^*) = V_g(P^*) - I, \frac{\partial V_b}{\partial P}\bigg|_{P^*} = \partial\left(\frac{V_g - I)}{\partial P}\right|_{P^*}.$$

A known result is that under uncertainty, the optimal retrofit threshold P^* exceeds the naive NPV breakeven point, reflecting the option value of waiting. Higher volatility increases this threshold. If there is a regulatory deadline, the option becomes finite-lived, often prompting exercise by that date if conditions are favorable.

Mathematical Derivation of the Retrofit Option Value

Formally, let $V_b(P)$ be the total value (brown-building value plus the retrofit option). In the continuation region (not retrofitting yet), V_b satisfies a PDE:

$$\frac{1}{2}\sigma^2 P^2 \frac{\partial^2 V_b}{\partial P^2} + \mu P \frac{\partial V_b}{\partial P} - rV_b + (R - \alpha - \beta P) = 0.$$

One seeks a solution that does not blow up as $P \to 0$, implying the coefficient of certain power terms must be set to zero. Post-retrofit, the value is $V_g(P)$ (green-building value), which similarly follows a PDE with the new cash flow $(R' - \alpha' - \beta' P)$. The exercise (retrofit) boundary is P^*, where

$$V_b(P^*) = V_g(P^*) - I, \frac{\partial V_b}{\partial P}\bigg|_{P^*} = \frac{\partial (V_g - I)}{\partial P}\bigg|_{P^*}.$$

Solving these boundary conditions yields P^* and the option value. Typically, $P^* > P_{\text{NPV}=0}$, illustrating the wait premium. If an abandonment option exists as

Table 4. Valuation of sustainability generated real options.

Option Type	Valuation Approach	Typical Trigger Variable
Option to Defer (Timing)	Modeled as an American call on retrofit payoff (Black–Scholes or binomial tree; free-boundary PDE for optimal exercise).	Optimal price threshold P* where waiting value = retrofit NPV.
Option to Abandon	Treated as an American put on brown-state value (strike = salvage proceeds), valued via binomial lattice or PDE.	Boundary condition where salvage value is greater than continuation value.
Option to Expand	Compound option: initial retrofit (option 1) + expansion (option 2), valued via two-stage binomial trees or nested Black–Scholes.	First trigger P* for initial, second trigger P** for deeper retrofit.
Option to Switch	Captured by a switching-option PDE (Dixit–Pindyck) or multi-state binomial tree with regime-switch costs.	Price or regulatory threshold where π_A(P) = π_B(P).

well, there is another boundary at a higher P^{**} where it is optimal to abandon rather than retrofit. Similar logic applies to switching options. The following table illustrates how decision triggers can be derived for the other types of real options described earlier.

Practical Examples

Example of an Office Building Retrofit

Consider a 20,000 m^2 office in Paris with an EPC rating of D. A retrofit costing €2 million cuts energy use by 50%, saving €200,000 per year plus a rent uplift of €100,000 per year. The static NPV might be positive, suggesting immediate retrofit. However, with uncertain future energy prices or carbon taxes, real options analysis might indicate waiting until a price threshold is met. If the volatility is large, the threshold can be significantly above the point where the retrofit just breaks even.

For illustration, the graph below shows building value $V(P)$ (in €100,000) versus energy price P with and without the retrofit option. The solid colored line is the optimal (option) value, and the gray dashed/dotted lines show the baseline (no retrofit) value and the value after immediate retrofit (net of cost). We label the static NPV = 0 breakeven and the optimal trigger P^* and have assigned P^* above the static break-even (NPV = 0), reflecting the "wait premium" under uncertainty. In our stylized example (retrofit cost €2M, saves ∼€200K/yr plus €100K rent), the NPV = 0 point occurs at a lower price, but the real-option threshold P^* is higher, and higher volatility shall push P^* even further.

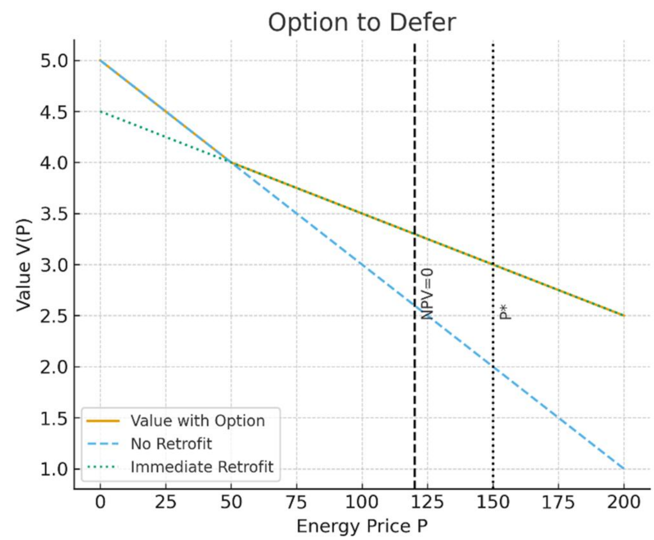

Figure 1. Example illustration of how value V changes with the energy price P for the option to defer retrofit.

Netherlands Label C Mandate

In the Netherlands, offices had to reach EPC C by 2023 or be deemed unusable. This regulatory deadline turned the retrofit decision into a finite-horizon option. Many owners waited until closer to 2023, hoping for cost declines or policy changes, but faced higher retrofit service demand. Those who did not retrofit had to remove their buildings from the office market.

Option to Switch Use

An older office building might be converted to residential use, which inherently has a lower carbon intensity. If office demand weakens or office upgrade regulations become too costly, the owner can switch to residential. Designing for easy conversion adds an embedded switching option that can raise the asset's value.

Portfolio Strategy

A fund with 50 buildings may classify them via CRREM analysis: retrofit prime assets, dispose of those with no feasible path, and keep options open on borderline cases, waiting for tech improvements or policy clarity. This approach is effectively a real option in practice.

Real options analysis offers a systematic approach to valuing managerial flexibility under uncertainty, treating opportunities such as expansion, abandonment, timing, or operational flexibility such as financial options. Traditional NPV methods often fail to capture the strategic value of deferring, switching, or abandoning projects under changing conditions. By modeling these managerial choices as options, decision-makers can better assess the actual value of investments.

Conclusion

EU sustainability regulations are fundamentally reshaping HBU valuation in real estate. Traditional valuation models must expand to incorporate new parameters (energy performance, carbon costs, compliance status) and to account for regulatory and market uncertainties. The analysis presented shows that sustainability considerations now influence all four criteria of HBU: legal, physical, financial, and maximum productivity. "Brown" assets face stranding or heavy retrofit costs, while "green" assets achieve premium rents, stronger occupancy, and better financing terms.

A real options framework enables valuation practitioners and investors to incorporate the value of flexibility under uncertainty explicitly. By modeling key uncertainties (energy prices, carbon taxes, regulation timing) as stochastic processes, analysts can derive optimal investment thresholds for retrofits or switching uses. The presence of regulatory deadlines, such as EPC requirements, effectively creates finite-horizon real options, forcing decisions by a specific date. Empirical evidence suggests that ignoring flexibility leads to mispricing, whereas real options theory clarifies the tradeoffs of investing early versus waiting.

As the EU moves toward its 2050 net-zero target, real estate strategies must align with a carbon-neutral trajectory. Buildings that cannot be upgraded risk stranding. Over time, today's green premium may become the standard, and laggards will see a widening brown discount. The combination of new regulations (EU Taxonomy, CSRD, SFDR, CSDDD) cements sustainability as a core driver of real estate value. Real options analysis provides a powerful method for navigating these uncertainties and optimizing HBU decisions in a rapidly evolving regulatory and market landscape.

Disclosure Statement

No potential conflict of interest was reported by the author(s).

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