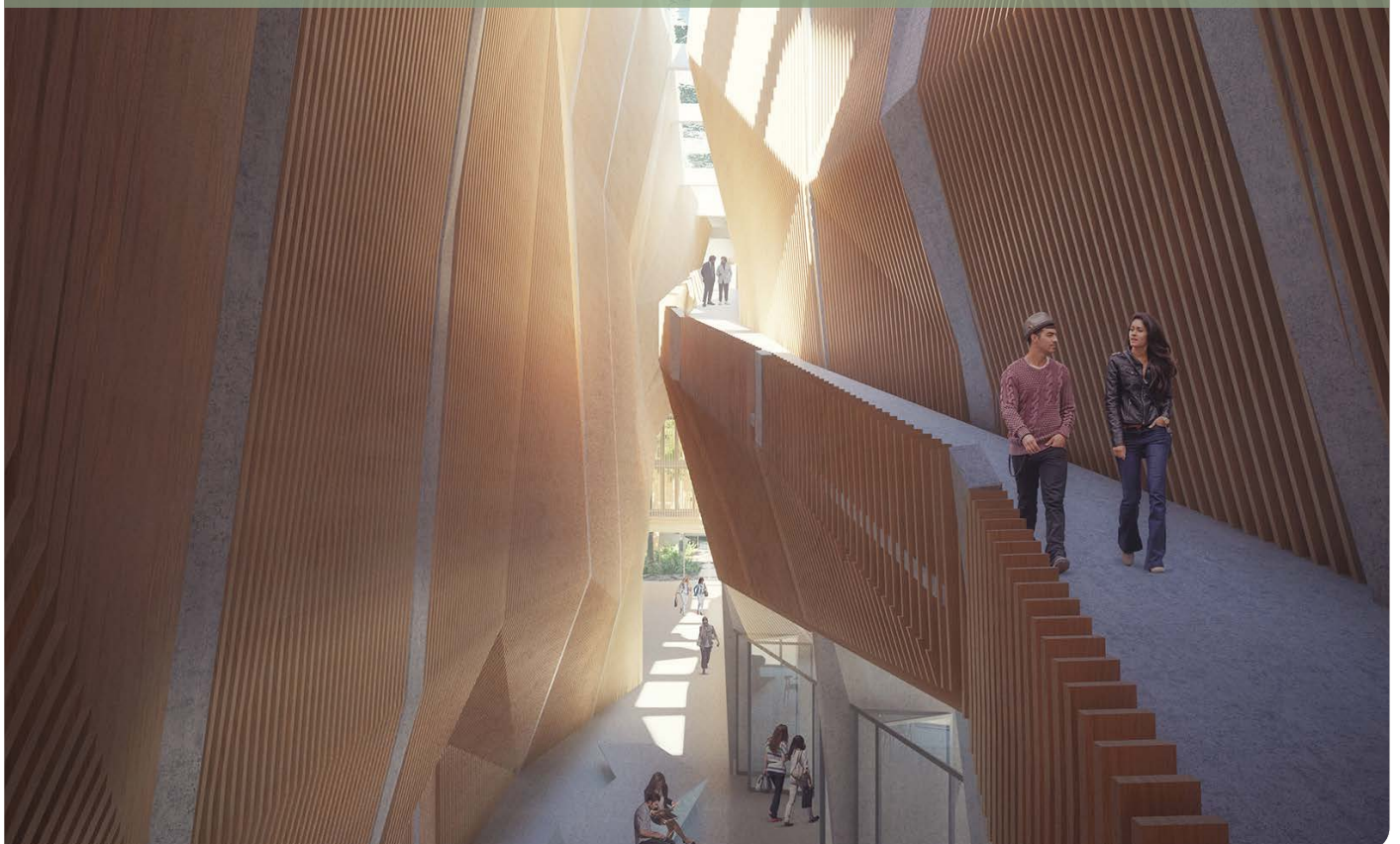


Briefing Paper

Delivering Sustainable Buildings: Savings and Payback Office Case Study for BREEAM UK New Construction 2018

Christopher Ward – BRE
Adam Mactavish – Currie & Brown



Introduction

BREEAM is the world's first and leading sustainability assessment and certification scheme for the built environment. The aim of the BREEAM family of schemes is to encourage continuous performance improvement and innovation by setting and assessing against a broad range of scientifically rigorous requirements that go beyond regulations and standard practice. It aims to empower those who own, commission, deliver, manage or use buildings to achieve their sustainability aspirations. It builds confidence and value in a project by providing independent certification that demonstrates the wider benefits to individuals, business, society and the environment. This means BREEAM rated developments are more sustainable environments that enhance the wellbeing of the people who live and work in them, help protect natural resources and make for more attractive property investments.

This study follows on from the previous work BRE has performed with Currie & Brown on the cost implications of achieving BREEAM UK New Construction 2011 and 2014 scheme assessment ratings of 'Very Good' and 'Excellent' for a model office building.^{1,2} Both studies have challenged the perception that sustainable buildings are inevitably more costly to build than those that simply comply with building regulations, and have added to the growing evidence base demonstrating the low costs of achieving greater sustainability, the operational savings available, the trend of reducing sustainability costs and the wider benefits of more sustainable buildings. The purpose of this study was to update the previous cost models for the office building case study to reflect current construction costs and the updated requirements in the current BREEAM UK New Construction 2018 scheme, in order to assess the capital cost and life cycle cost and savings outcomes of achieving 'Very Good' and 'Excellent' ratings for the latest version of the scheme.



The authors would like to thank Azita Dezfouli for her contribution to this project.

Cost model scenarios

The office case study model is the same as that used in the BREEAM UK New Construction 2011 and 2014 studies, i.e. a town or city centre located speculative building comprising of five storeys of office accommodation and a central atrium. It is a high-quality space, intended to attract tenants with an interest in sustainability. The gross floor area is 13,800 m², with net office space floor area of 11,150 m². It is of steel frame construction with concrete floors and glazed curtain walling. Services include air conditioning by fan-coil units served by gas boilers and water-cooled chillers, efficient lighting, and instantaneous electrically heated hot water to all toilet and kitchen areas.

The BREEAM UK New Construction 2014 study developed the following scenarios for the office case study:

1. Building Regulations Approved Document L2A³ compliant baseline building.
2. BREEAM 'Very Good' rated building.
3. BREEAM 'Excellent' rated building.
4. London Plan Policy 5.2⁴ compliant BREEAM 'Very Good' rated building.
5. London Plan Policy 5.2 compliant BREEAM 'Excellent' rated building.

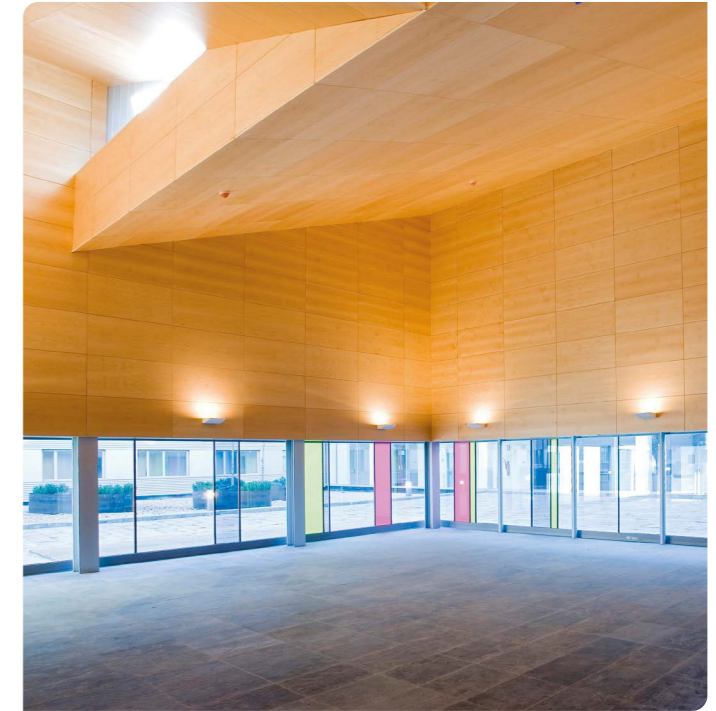
The BREEAM UK New Construction 2018 scheme introduced various new and updated requirements that have impacted the suite of credits that were selected to achieve the 'Very Good' and 'Excellent' ratings in the BREEAM UK New Construction 2014 study. Additionally, the construction costs used in the previous study were based on those from 2016. Therefore, the following tasks were performed in order to update the cost models for the five scenarios:

- Assessment of the cost implications of implementing the new and updated BREEAM UK New Construction 2018 requirements relevant to the credits achieved in the previous study.
- Review and update of the capital cost model inputs to ensure these reflect current market rates.
- Review and update of the suites of credits required to achieve 'Very Good' and 'Excellent' ratings.
- Review and update of the energy and water life cycle cost model inputs to ensure these reflect current market rates.
- Re-run the capital cost and life cycle cost models to generate updated outputs for the 'Very Good' and 'Excellent' rated scenarios.

By designing to the BREEAM standards we aim to save 40-60% of our current energy costs in the head office complex. Our new home will create a benchmark for every other UK business and showcase what can be achieved through a socially responsible approach to design and construction.

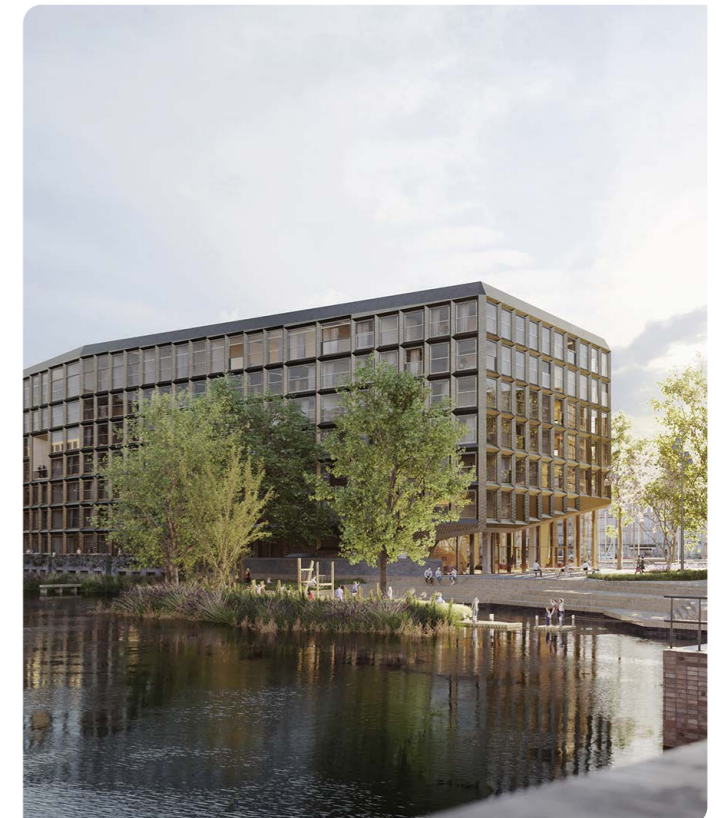
The Co-operative Group on
One Angel Square, Manchester

- 1 FB63: Delivering sustainable buildings – Savings and payback; IHS BRE Press; 2014
- 2 BREEAM Briefing Paper: Delivering Sustainable Buildings: Savings and Payback – Office Case Study for BREEAM UK New Construction 2014; BRE; 2017
- 3 The Building Regulations 2010 Approved Document L2A: Conservation of fuel and power in new buildings other than dwellings – 2013 edition incorporating 2016 amendments – for use in England; HM Government; 2016
- 4 The London Plan – Policy 5.2 Minimising Carbon Dioxide emissions; Greater London Authority; 2016



Delivering low carbon and sustainable buildings has never been more critical, so it is encouraging that significant improvements can be achieved for little upfront cost and with rapid paybacks.

Adam Mactavish, Director –
Currie & Brown



Impact of updated BREEM UK New Construction 2018 requirements

The requirements for several of the credits that were targeted in the BREEM UK New Construction 2014 study were significantly updated for the BREEM UK New Construction 2018 scheme. In addition, some completely new credits were introduced into the scheme. Table 1 summarises the requirements that were introduced to or significantly revised in BREEM UK New Construction 2018 that are relevant to the study, as well as a broad analysis of the likelihood of any related costs. In most cases, these changes are not anticipated to have significant capital cost implications for projects, with costs largely related to additional design team or consultant time. The category weightings were also updated in BREEM UK New Construction 2018, which could potentially have an impact on the how the credits selected in the previous study contribute to the overall BREEM assessment score and whether this achieves the minimum score required for a 'Very Good' or 'Excellent' rating.

As highlighted in Table 1, the number of credits and associated energy performance benchmarks were changed in the BREEM UK New Construction 2018 'Ene 01 Reduction of energy use and carbon emissions' assessment issue. It is a minimum requirement to attain four Ene 01 energy performance credits in order to achieve an 'Excellent' rating. Consequently, it was necessary to re-run the energy performance models for the two 'Excellent' rated scenarios that were developed for the BREEM UK New Construction 2014 study to assess how these would perform against the updated Ene 01 credit benchmarks.⁵ The previous energy models, including that for the baseline building, were developed using the Simplified Building Energy Model (SBEM). These were re-run using the latest version of SBEM (v5.6a) and the relevant outputs entered into the BREEM UK New Construction 2018 Ene 01 Calculator tool. This exercise demonstrated the following:

- The energy performance of the baseline building scenario was still Approved Document L2A compliant.
- The London Plan 'Excellent' rated scenario still met the minimum energy performance requirements for an 'Excellent' rating and achieved five out of the available nine credits.
- The 'Excellent' (non-London Plan) rated scenario achieved three out of the available nine credits, so did not meet the minimum number of credits for an 'Excellent' rating. To achieve the necessary four credits, and to align with the energy performance improvements that were previously implemented for the London Plan 'Excellent' rated scenario, it was decided to improve the energy performance by upgrading the building's air handling unit plate heat exchangers to run around coils with variable heat recovery efficiency. Re-running the energy model with this improvement increased the overall energy performance ensuring that four credits were achieved.

/// Securing these savings in practice will require attention to detail in construction, commissioning and management post-occupation. This will maximise the environmental and financial returns on the investment in building performance. ///

Adam Mactavish, Director
– Currie & Brown

Also as summarised in Table 1, the water using component water efficiency benchmarks were updated in the BREEM UK New Construction 2018 'Wat 01 Water consumption' assessment issue. Compared to the requirements in BREEM UK New Construction 2014, this has the consequence of requiring slightly improved water using component efficiencies in order to meet the different credit benchmarks for percentage improvement over baseline building water consumption.



As such, the water saving options selected to achieve the different Wat 01 credits in the BREEM UK New Construction 2014 study were re-evaluated using the updated BREEM UK New Construction 2018 Wat 01 Calculator tool. This showed that the performance of the water saving options fell short of the benchmarks for the 2nd, 3rd and 4th Wat 01 credits. In each of these cases, a slight water efficiency improvement to the taps specified in the building was enough to be able meet the Wat 01 benchmarks. The updated water saving options for each of the Wat 01 credits were as follows:

- 1st credit: Dual flush toilets (6 and 4 litres flush volumes).
- 2nd credit: Dual flush toilets (6 and 4 litres flush volumes) and low flow taps (6 litres per minute flow rate).
- 3rd credit: Dual reduced flush toilets (4 and 2 litres flush volumes) and low flow taps (6 litres per minute flow rate).
- 4th credit: Dual reduced flush toilets (4 and 2 litres flush volumes), waterless urinals, low flow taps in kitchen areas (6 litres per minute flow rate) and very low flow taps in toilet areas (4 litres per minute flow rate).
- 5th credit: Dual reduced flush toilets (4 and 2 litres flush volumes), waterless urinals, low flow taps (6 litres per minute flow rate) and rainwater harvesting system to feed toilets.

Changes in construction costs between studies

Currie & Brown reviewed the capital costs that were applied in order to achieve the requirements for each of the BREEM credits in the BREEM UK New Construction 2014 study, which were based on costs from the first quarter (Q1) of 2016. Where credit requirements did not change materially in BREEM UK New Construction 2018, costs were updated to reflect those for the fourth quarter (Q4) of 2019 using:

- Tendered price estimates for products or services.
- Current consultancy fees expressed as day rates.
- Construction cost inflation indices.

As in the previous studies, the costs associated with achieving BREEM credits over and above the construction costs of the baseline building include all 'on costs' as applicable (e.g. materials, labour, professional fees and main contractor preliminaries, overheads and profit), and all costs exclude VAT. Where new credit requirements were introduced in BREEM UK New Construction 2018, Currie & Brown used their experience of performing BREEM assessments to estimate the potential cost implications of demonstrating compliance against the requirements for the office case study building (based on Q4 2019 rates). As part of the analysis, the baseline total construction costs for the office building were adjusted to reflect Q4 2019 costs. This led to an approximate 5% increase in the baseline construction costs to £35.88 million, i.e. before consideration of the impacts of meeting the BREEM UK New Construction 2018 requirements.

/// This is our first BREEM Excellent rated building under BREEM New Construction, and one of seven total office schemes to have so far been certified. The handful of schemes meeting the high standards set the bar for future developments in London and across the country. ///

Andrew Grint, Project Director for
240 Blackfriars Road, London



⁵ The energy performance improvements made to the baseline building for both 'Excellent' rated scenarios in the BREEM UK New Construction 2014 study were:

- Non-London Plan – High efficiency LED lighting in all office areas and high efficiency T5 lighting in circulation, toilet and storage areas.
- London Plan – High efficiency lighting as non-London Plan scenario; high efficiency air source heat pumps for heating and cooling; high efficiency run around coils heat recovery system with variable heat recovery efficiency; and low specific fan powers for ventilation system terminal units.



Credit selection to achieve BREEAM UK New Construction 2018 'Very Good' and 'Excellent' ratings

The strategy used previously in both studies to select credits to achieve 'Very Good' and 'Excellent' ratings was to favour the most cost-effective options and routes to BREEAM compliance, i.e. with a focus on minimising capital costs. The same strategy was applied to the current study. In terms of selecting suites of credits for the BREEAM UK New Construction 2018 'Very Good' and 'Excellent' rated scenarios, where no significant changes had been made to the credit requirements selected for the BREEAM New Construction 2014 study, these credits were retained. Additional credits were then selected based on their cost-effectiveness to incrementally increase the overall BREEAM scores for each scenario to achieve the minimum scores for 'Very Good' and 'Excellent' ratings.

Table 2 lists the credits for each of the four scenarios that were selected to take the baseline building specification up to 'Very Good' and 'Excellent' ratings. As highlighted in the BREEAM UK New Construction 2014 study, several BREEAM credits are likely to be achieved by current industry standard practice for town or city centre office developments, as this performance is expected by investors and tenants in the absence of a BREEAM rating. These credits have been assigned as 'Industry Standards' in Table 2. Costs relating to these 'Industry Standards' have been excluded from the BREEAM related uplift costs as these would be covered in the baseline building specification. Similarly, the costs for improving the baseline building's energy performance to meet the London Plan Policy 5.2 requirements, which enable the two London Plan scenarios to achieve five credits for the Ene 01 assessment issue, are not included in the BREEAM related uplift costs, as these would be covered in the baseline construction costs for the two London Plan scenarios.

Table 3 shows the capital cost implications of achieving BREEAM UK New Construction 2018 'Very Good' and 'Excellent' ratings for the four case study office building scenarios. For both 'Very Good' scenarios, the BREEAM related capital cost uplifts over the baseline building's construction costs are less than 0.25%. In the case of the two 'Excellent' scenarios, the BREEAM related capital cost uplifts over baseline building's total construction costs are less than 0.75%. Table 3 also includes a comparison of the BREEAM related uplifts with the previous study. These results suggest that the update from BREEAM UK New Construction 2014 to BREEAM UK New Construction 2018 has had very little impact on the percentage cost uplift of achieving 'Very Good' or 'Excellent' ratings, albeit that the overall costs are higher due to general increases in construction costs since the previous study.



Life cycle costs and savings

It is now widely recognised that investing in and implementing more environmentally sustainable solutions can reduce the operational costs of a building that is properly managed, most notably through reduced energy and water bills. The life cycle savings and payback periods of investing in more sustainable solutions should be considered by clients and design teams, as well as the initial capital costs. As performed for the previous studies, the life cycle costs and savings were evaluated using the same life cycle cost models for the following:

- Implementation of the energy performance improvements selected to meet the minimum requirements for an 'Excellent' rating in the Ene 01 assessment issue.
- Implementation of the water saving measures selected to achieve the water efficiency benchmarks for the different credits in the Wat 01 assessment issue.

For the purposes of this study, life cycle cost periods of 25 years and 20 years were examined for the energy and water improvements, respectively. These periods reflect the estimated service life of the systems, plant, equipment and fittings. The analysis considered capital expenditure, utility bills, planned maintenance, reactive maintenance and capital replacement. The analysis excluded VAT, statutory charges, capital allowances, tax adjustments and out-of-hours premiums. Results of the analysis are presented on a discounted and undiscounted basis, reflecting present value and future value, respectively. A discount rate of 3.5% was used based on the current Treasury Green Book rate.

Table 4 illustrates the energy related life cycle costs and savings for the two 'Excellent' rated scenarios. Energy savings over the baseline building energy performance are based on the outputs from the SBEM assessments. The energy tariffs used were based on the current Department for Business, Energy and Industrial Strategy (BEIS) energy and emissions projections for electricity and natural gas retail prices. As one might expect, the payback period for investment in energy efficiency options is sensitive to the energy price, but all prices result in savings paid back well in advance of typical system life expectancy. The non-London Plan BREEAM 'Excellent' scenario shows short undiscounted and discounted payback periods of 5 years or less for all energy price scenarios. While the London Plan scenario shows slightly longer payback periods, it should be noted that the capital costs for meeting the London Plan requirements are not directly associated with achieving the BREEAM 'Excellent' rating.

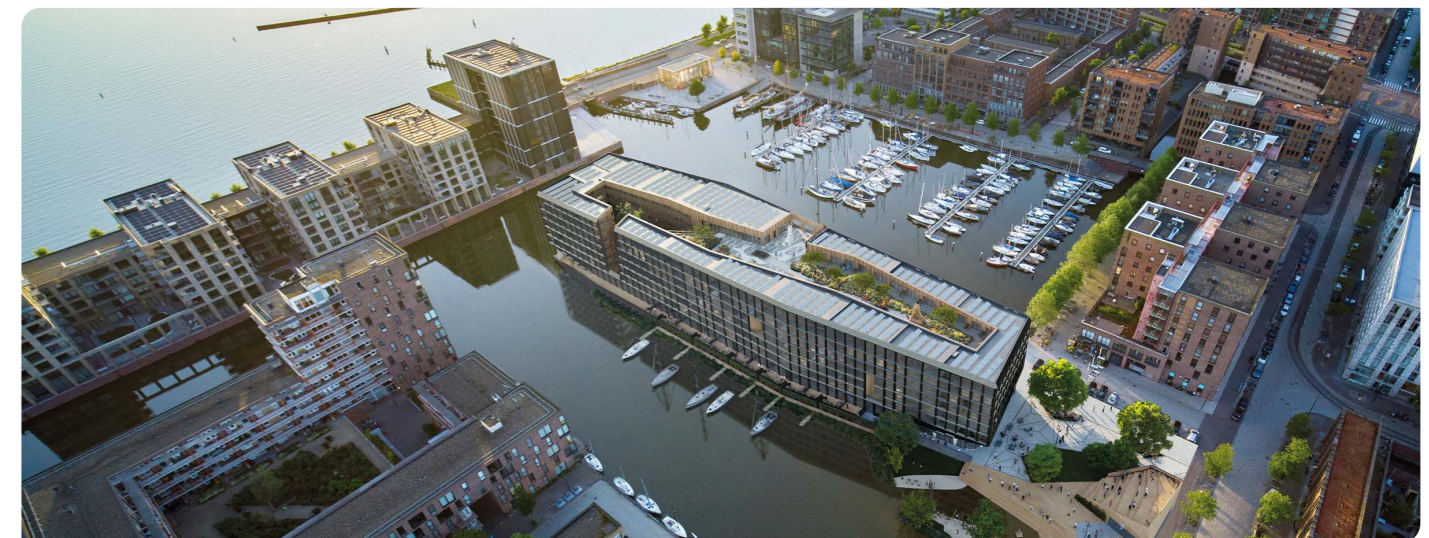
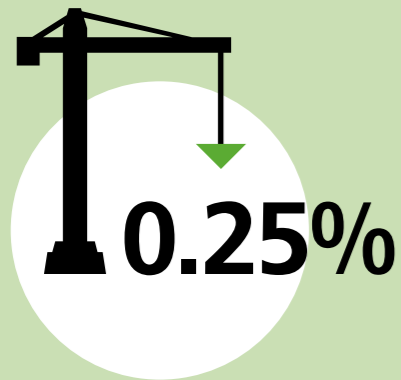


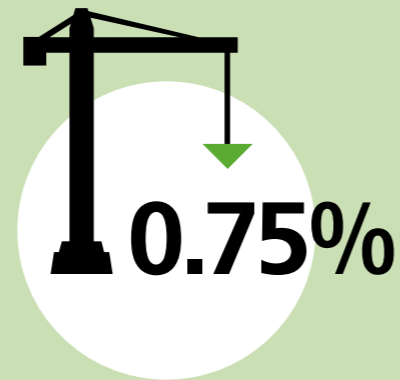
Table 5 presents the life cycle costs and savings of achieving increasing numbers of Wat 01 credits water efficiency for two different water tariffs. The variations in UK water prices are expressed by upper and lower tariffs for water and wastewater services, and the analysis include a 0.5% tariff increase per year. The lower tariff was £2.13/m³ (Thames Water) and the higher tariff was £5.23/m³ (South West Water). The costs and savings are cumulative, e.g. the cost of achieving three credits includes the cost of achieving the first two credits. Water savings over the baseline building consumption were calculated using the BREEAM UK New Construction 2018 Wat 01 Calculator tool. As with the energy savings, the payback period for investment in water saving options is sensitive to the tariff imposed by the local water company. For the first four Wat 01 credits, the selected water efficiency measures show undiscounted and discounted payback periods of 3 years or less for both tariffs. For the fifth Wat 01 credit, which requires a significant capital cost investment for installing a rainwater harvesting system, payback periods are still well in advance of the typical system life expectancy, other than for the low water tariff discounted rate scenario. However, for the purposes of achieving the BREEAM ratings in this study, none of the four scenarios targeted this high capital cost credit.

Conclusions

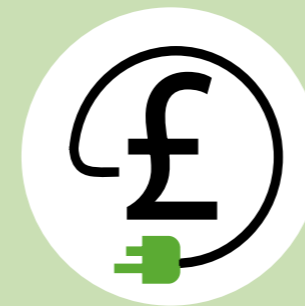
This report has updated the previous BREEAM UK New Construction 2014 study's capital and life cycle cost models for a case study office building in order to reflect current construction costs and the updated requirements in the BREEAM UK New Construction 2018 scheme. The study has assessed the capital and life cycle cost implications for the office building to achieve BREEAM 'Very Good' and 'Excellent' ratings with and without compliance to the requirements of London Plan Policy 5.2. The study has shown:



For both 'Very Good' scenarios, the BREEAM related capital cost uplifts over the baseline building's overall construction costs are less than 0.25%.



For the two 'Excellent' scenarios, the BREEAM related capital cost uplifts over baseline building's total construction costs are less than 0.75%.



The non-London Plan BREEAM 'Excellent' scenario shows short undiscounted and discounted payback periods of 5 years or less for all energy price scenarios.



While the London Plan 'Excellent' scenario shows slightly longer payback periods, it should be noted that the capital costs for meeting the London Plan requirements are not directly associated with achieving the BREEAM 'Excellent' rating.



When compared to the uplifts in the BREEAM UK New Construction 2014 study, the updated requirements in the BREEAM UK New Construction 2018 scheme have had very little impact on the additional capital costs of achieving 'Very Good' or 'Excellent' ratings.



The savings from the energy efficiency improvement measures required to achieve 'Excellent' ratings are forecast to quickly payback the additional capital investment.



The savings from the water efficiency measures selected to achieve the requirements for the first four BREEAM 'Wat 01 Water consumption' credits show undiscounted and discounted payback periods of 3 years or less for both tariffs.

This study reiterates the findings from the previous studies that, where properly implemented, sustainability strategies and solutions add little to the capital costs of new buildings, and that where there is an additional capital cost for a sustainable solution, these solutions quickly payback through their operational savings. This demonstrates the importance of considering life cycle as well as capital costs when procuring and investing in new buildings. In order to secure the benefits of such sustainability strategies, it is essential that these issues are considered as early as possible in the design process and that the buildings are operated efficiently and as intended.

Table 1: New and significantly updated assessment issue requirements in BREEAM UK New Construction 2018 and potential cost implications

Assessment Issue		New Requirements	Cost Implications
Ene 01	Reduction of energy use and carbon emissions	Reduced number of energy performance credits and updated energy performance benchmarks. New credits for prediction of operational energy consumption using more detailed energy modelling.	Possible costs for additional energy improvement measures to meet the revised benchmark for an 'Excellent' rating. Additional fees for design team and energy modeller's time and report (estimated 15-20 days).
Tra 01	Transport assessment and travel plan	New issue incorporates previous requirements for a travel plan and the reporting of the existing site's Accessibility Index and accessible amenities. Reduced number of credits.	No additional costs expected as requirements are very similar to those in BREEAM UK New Construction 2014.
Tra 02	Sustainable transport measures	New issue incorporating previous cyclist facility criteria, which requires implementation of sustainable transport measures based on analysis of the existing situation. Increased number of credits.	No additional costs expected as requirements are very similar to those in BREEAM UK New Construction 2014.
Wat 01	Water consumption	Water efficient consumption benchmarks updated for different water using components.	Possible costs for additional water efficiency measures to meet the revised benchmarks for 'Very Good' and 'Excellent' ratings.
Mat 01	Environmental impacts from construction products – Building life cycle assessment (LCA)	Issue significantly updated to focus on LCA at the whole building level rather than at the building element level.	Additional fees for design team to perform assessment (estimated 2 days for using BREEAM Simplified Building LCA tool).
Mat 02	Environmental impacts from construction products – Environmental Product Declarations (EPD)	New issue that encourages the specification of construction products with EPDs across different materials.	Additional fees for design team to evaluate the materials used and to source EPDs (estimated 3-4 days).
Wst 02	Use of recycled and sustainably sourced aggregates	Issue updated to include recognition of the use of locally and sustainably sourced primary aggregates as well as recycled aggregates, including introduction of a new calculation methodology.	Additional fees for design team to collate the relevant information and input into the BREEAM Wst 02 calculator (estimated 1 day).
Wst 06	Design for disassembly and adaptability	Additional credit for demonstrating the implementation of disassembly and adaptability solutions.	Additional fees for design team to update the study and produce building adaptability and disassembly guide (estimated 1 day).
LE 02	Ecological value of site and protection of ecological features	Issue re-written to focus on understanding the ecological baseline of the site, and the risks and opportunities for the project.	Updated requirements are likely to involve similar design team and ecologist costs as those in BREEAM UK New Construction 2014.
LE 03	Managing impacts on ecology	Issue re-written to reward management of potential negative impacts to ecology on site.	Updated requirements are likely to involve similar design team and ecologist costs as those in BREEAM UK New Construction 2014.
LE 04	Ecological change and enhancement	Issue re-written to reward measures taken to enhance the ecology on site.	Updated requirements are likely to involve similar design team and ecologist costs as those in BREEAM UK New Construction 2014.
LE 05	Long term ecology management and maintenance	Issue re-written to focus on management and maintenance of new and existing ecological features.	Updated requirements are likely to involve similar design team and ecologist costs as those in BREEAM UK New Construction 2014.
Pol 02	Local air quality	Issue updated to focus on local air quality impacts from combustion appliances including new emission benchmarks for NOx, VOCs and particulate matter.	No additional costs expected as it is assumed HVAC specification would include a compliant low NOx gas boiler and electric heat pumps achieve maximum credits by default.

Table 2: Targeted credits for 'Very Good' and 'Excellent' ratings

Assessment Issue	Credit	N° of Credits	Industry Standard	Non-London Plan		London Plan		
				BREEAM Very Good	BREEAM Excellent	BREEAM Very Good	BREEAM Excellent	
Management								
Man 01	Project brief and design	Project delivery planning	1	No	Yes	Yes	Yes	Yes
Man 01	Project brief and design	Stakeholder consultation (interested parties)	1	No	Yes	Yes	Yes	Yes
Man 01	Project brief and design	BREEAM Advisory Professional (Concept Design)	1	No	Yes	Yes	Yes	Yes
Man 01	Project brief and design	BREEAM Advisory Professional (Developed Design)	1	No	Yes	Yes	No	Yes
Man 02	Life cycle cost and service life planning	Elemental lifecycle cost (LCC)	2	No	Yes	Yes	No	Yes
Man 02	Life cycle cost and service life planning	Component level LCC option appraisal	1	No	Yes	Yes	No	Yes
Man 02	Life cycle cost and service life planning	Capital cost reporting	1	No	Yes	Yes	No	Yes
Man 03	Responsible construction practices	Environmental management	1	No	Yes	Yes	Yes	Yes
Man 03	Responsible construction practices	BREEAM Advisory Professional (Site)	1	No	Yes	Yes	Yes	Yes
Man 03	Responsible construction practices	Responsible construction management	1	No	Yes	Yes	Yes	Yes
Man 03	Responsible construction practices	Monitoring of construction site impacts – utility consumption	1	Yes	Yes	Yes	Yes	Yes
Man 03	Responsible construction practices	Monitoring of construction site impacts – transportation of construction materials and waste	1	No	No	Yes	No	Yes
Man 04	Commissioning and handover	Commissioning – testing schedule and responsibilities	1	Yes	Yes	Yes	Yes	Yes
Man 04	Commissioning and handover	Commissioning – design and preparation	1	Yes	Yes	Yes	Yes	Yes
Man 04	Commissioning and handover	Testing and inspecting building fabric	1	No	No	Yes	No	Yes
Man 04	Commissioning and handover	Handover	1	Yes	Yes	Yes	Yes	Yes
Man 05	Aftercare	Aftercare support	1	No	No	Yes*	No	No
Man 05	Aftercare	Commissioning – implementation	1	Yes	Yes	Yes	Yes	Yes
Man 05	Aftercare	Post-occupancy evaluation (POE)	1	No	Yes	Yes	Yes	Yes
Health and Wellbeing								
Hea 01	Visual comfort	Control of glare from sunlight	1	Yes	Yes	Yes	Yes	Yes
Hea 01	Visual comfort	View out	1	Yes	Yes	Yes	Yes	Yes
Hea 01	Visual comfort	Internal and external lighting levels, zoning and controls	1	Yes	Yes	Yes	Yes	Yes

Table 2: Targeted credits for 'Very Good' and 'Excellent' ratings (Cont.)

Assessment Issue		Credit	N° of Credits	Industry Standard	Non-London Plan		London Plan	
					BREEAM Very Good	BREEAM Excellent	BREEAM Very Good	BREEAM Excellent
Hea 01	Indoor air quality	Ventilation	1	No	Yes	Yes	Yes	Yes
Hea 02	Indoor air quality	Emissions from construction products	1	No	Yes*	Yes	Yes*	Yes
Hea 02	Indoor air quality	Post construction indoor air quality measurement	1	No	No	Yes	No	Yes
Hea 04	Thermal comfort	Thermal modelling	1	No	Yes	Yes	No	Yes
Hea 04	Thermal comfort	Design for future thermal comfort	1	No	Yes*	Yes	No	Yes*
Hea 04	Thermal comfort	Thermal zoning and controls	1	No	Yes	Yes	No	Yes
Hea 05	Acoustic performance	Sound insulation	1	No	Yes	Yes	Yes	Yes
Hea 05	Acoustic performance	Indoor ambient noise level	1	No	Yes	Yes	No	Yes
Hea 05	Acoustic performance	Room acoustics	1	No	Yes	Yes	Yes	Yes
Hea 06	Safety and Security	Security of site and building	1	Yes	Yes	Yes	Yes	Yes
Energy								
Ene 01	Reduction of energy use and carbon emissions	Achieve Energy Performance Ratio for New Construction ($EPR_{NC} \geq 0.4$)	4	No	No	Yes	No	No
Ene 01	Reduction of energy use and carbon emissions	Achieve Energy Performance Ratio for New Construction ($EPR_{NC} \geq 0.5$)	5	Yes#	No	No	Yes	Yes
Ene 01	Reduction of energy use and carbon emissions	Prediction of operational energy consumption – Energy modelling and reporting	4	No	No	Yes*	No	Yes*
Ene 02	Energy monitoring	Sub-metering of end use categories	1	No	Yes	Yes	Yes	Yes
Ene 02	Energy monitoring	Sub-metering of high energy load and tenancy areas	1	No	Yes	Yes	Yes	Yes
Ene 03	External lighting	External lighting	1	Yes	Yes	Yes	Yes	Yes
Ene 04	Low carbon design	Passive design analysis	1	No	Yes*	Yes	No	Yes
Ene 04	Low carbon design	Low zero carbon feasibility study	1	No	No	Yes	Yes*	Yes
Ene 06	Energy efficient transportation systems	Energy consumption	1	No	No	Yes*	No	No
Ene 06	Energy efficient transportation systems	Energy efficient features – Lifts	1	No	No	Yes*	No	No
Ene 08	Energy efficient equipment	Energy efficient equipment	2	No	Yes	Yes	Yes	Yes
Transport								
Tra 01	Transport assessment and travel plan	Transport assessment and travel plan	2	Yes	Yes	Yes	Yes	Yes
Tra 02	Sustainable transport measures	Transport assessment and travel plan	6	Yes	Yes	Yes	No	No
Tra 02	Sustainable transport measures	Transport assessment and travel plan	8	Yes	No	No	Yes	Yes

Table 2: Targeted credits for 'Very Good' and 'Excellent' ratings (Cont.)

Assessment Issue		Credit	N° of Credits	Industry Standard	Non-London Plan		London Plan	
					BREEAM Very Good	BREEAM Excellent	BREEAM Very Good	BREEAM Excellent
Water								
Wat 01	Water consumption	Water consumption – 12.5% improvement over baseline	1	No	Yes	No	Yes	No
Wat 01	Water consumption	Water consumption – 40% improvement over baseline	3	No	No	No	No	Yes*
Wat 01	Water consumption	Water consumption – 50% improvement over baseline	4	No	No	Yes*	No	No
Wat 02	Water monitoring	Water monitoring	1	Yes	Yes	Yes	Yes	Yes
Wat 03	Leak detection	Leak detection system	1	No	Yes	Yes	Yes	Yes
Wat 03	Leak detection	Flow control devices	1	No	No	Yes*	No	Yes*
Wat 04	Water efficient equipment	Water efficient equipment	1	Yes	Yes	Yes	Yes	Yes
Materials								
Mat 01	Environmental impacts from construction products – Building life cycle assessment (LCA)	Superstructure	2	No	Yes*	Yes*	Yes*	Yes*
Mat 02	Environmental impacts from construction products – Environmental Product Declarations (EPD)	Specification of products with a recognised environmental product declaration (EPD)	1	No	Yes*	Yes*	Yes*	Yes*
Mat 03	Responsible sourcing of construction products	Sustainable procurement plan	1	Yes	Yes	Yes	Yes	Yes
Mat 03	Responsible sourcing of construction products	Measuring responsible sourcing $\geq 10\%$ points achieved	1	Yes	Yes	Yes	Yes	Yes
Mat 05	Designing for durability and resilience	Designing for durability and resilience	1	Yes	Yes	Yes	Yes	Yes
Mat 06	Material efficiency	Material efficiency	1	No	Yes*	Yes	Yes*	Yes
Waste								
Wst 01	Construction waste management	Pre-demolition audit	1	Yes	Yes	Yes	Yes	Yes
Wst 01	Construction waste management	Construction resource efficiency – waste generated $\leq 7.5 \text{ m}^3$ or ≤ 6.5 tonnes per 100 m^2	2	No	Yes	Yes	Yes	Yes
Wst 01	Construction waste management	Diversion of resources from landfill	1	Yes	Yes	Yes	Yes	Yes
Wst 02	Use of recycled and sustainably sourced aggregates	Project Sustainable Aggregate Points	1	No	Yes*	Yes*	Yes*	Yes*
Wst 03	Operational waste	Operational waste	1	Yes	Yes	Yes	Yes	Yes
Wst 04	Speculative finishes	Speculative floor and ceiling finishes	1	Yes	Yes	Yes	Yes	Yes
Wst 05	Adaptation to climate change	Resilience of structure, fabric, building services and renewables installation	1	No	No	Yes	No	Yes
Wst 06	Design for disassembly and adaptability	Design for disassembly and functional adaptability – recommendations	1	Yes	Yes	Yes	Yes	Yes
Wst 06	Design for disassembly and adaptability	Disassembly and functional adaptability – implementation	1	No	Yes*	Yes*	Yes*	Yes*

Table 2: Targeted credits for 'Very Good' and 'Excellent' ratings (Cont.)

Assessment Issue	Credit	N° of Credits	Industry Standard	Non-London Plan		London Plan		
				BREEAM Very Good	BREEAM Excellent	BREEAM Very Good	BREEAM Excellent	
Land Use and Ecology								
LE 01	Site selection	Previously occupied land	1	Yes	Yes	Yes	Yes	Yes
LE 02	Ecological value of site and protection of ecological features	Survey and evaluation and determining the ecological outcomes (Route 1)	1	No	Yes*	Yes*	Yes*	Yes*
LE 03	Managing impacts on ecology	Planning and measures on-site (Route 1)	1	No	Yes*	Yes*	Yes*	Yes*
LE 03	Managing impacts on ecology	Managing negative impacts (Route 1)	1	No	Yes*	Yes*	Yes*	Yes*
LE 04	Ecological change and enhancement	Change and enhancement of ecology (Route 1)	1	No	No	Yes*	No	Yes*
LE 05	Long term ecology management and maintenance	Management and maintenance throughout the project and landscape and ecology management plan (Route 1)	1	No	Yes*	Yes*	Yes*	Yes*
Pollution								
Pol 01	Impact of refrigerants	Impact of refrigerant – DELC of ≤ 100 kgCO ₂ -eq/kW	2	Yes	Yes	Yes	Yes	Yes
Pol 02	Local air quality	Local air quality	2	No	Yes	Yes	Yes	Yes
Pol 03	Flood and surface water management	Flood resilience – medium or high flood risk	1	Yes	Yes	Yes	Yes	Yes
Pol 03	Flood and surface water management	Surface water run-off – Rate	1	No	Yes	Yes	Yes	Yes
Pol 03	Flood and surface water management	Surface water run-off – Volume	1	No	Yes	Yes	Yes	Yes
Pol 03	Flood and surface water management	Minimising watercourse pollution	1	No	Yes*	Yes*	Yes*	Yes*
Pol 04	Reduction of night time light pollution	Reduction of night time light pollution	1	Yes	Yes	Yes	Yes	Yes
Pol 05	Reduction of noise pollution	Reduction of noise pollution	1	Yes	Yes	Yes	Yes	Yes
* Credits targeted in the UK New Construction 2018 study that were not targeted in UK New Construction 2014 study								
# Only for London Plan scenarios								

Table 3: Capital cost analysis for BREEAM UK New Construction 2018 'Very Good' and 'Excellent' ratings

Office building scenario	Capital cost of 'Industry Standard' credits	Baseline building capital costs including 'Industry Standard' costs	Additional capital costs of credits selected to achieve BREEAM rating	BREEAM related uplift over baseline capital costs	BREEAM related uplift in BREEAM UK New Construction 2014 study
BREEAM 'Very Good'	£235,300	£36,115,300	£87,000	0.24%	0.25%
BREEAM 'Excellent'	£235,300	£36,115,300	£271,100	0.75%	0.65%
London Plan compliant BREEAM 'Very Good'	£388,600	£36,268,600	£62,700	0.17%	0.15%
London Plan compliant BREEAM 'Excellent'	£388,600	£36,268,600	£156,100	0.43%	0.35%

Table 4: Life cycle costs and savings for the energy improvement measures implemented for the two 'Excellent' rated scenarios

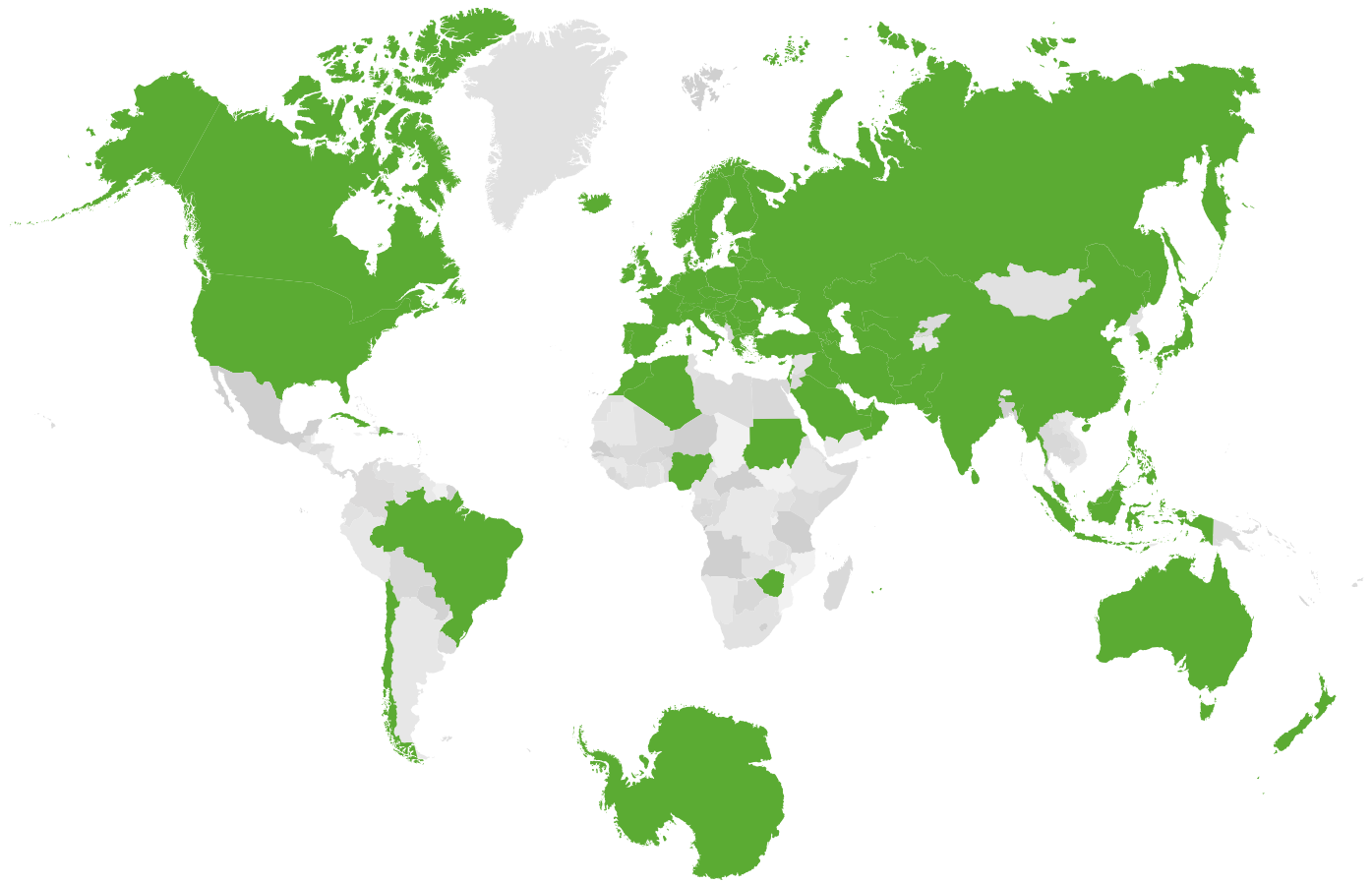
Ene 01 scenario	Energy price	Annual gas savings over baseline (kWh)	Annual electricity savings over baseline (kWh)	Capital cost uplift above baseline	Undiscounted life cycle savings over 25 years	Undiscounted payback period (years)	Discounted net savings over 25 years	Discounted payback period (years)
Non-London Plan	Base	-19,274	189,361	£75,191	£594,816	3.2	£400,732	4.7
	High				£629,264	3	£424,813	4.4
	Low				£553,904	3.4	£373,333	5
London Plan	Base	129,354	181,811	£153,334*	£608,456	6.3	£418,708	9.2
	High				£665,461	5.8	£457,707	8.4
	Low				£536,452	7.1	£372,399	10.3

* Not included in the BREEAM capital cost uplift for meeting the 'Excellent' rating requirements as this energy performance is required and paid for by complying with the London Plan

Table 5: Life cycle costs and savings for the water efficiency measures implemented for the Wat 01 credits

Water price	Wat 01 scenario	Annual water consumption (m ³)	Water savings over baseline (m ³)	Capital cost over baseline	Undiscounted net savings over 20 years	Undiscounted payback period (years)	Discounted net savings over 20 years	Discounted payback period (years)
Low	Baseline	9,567	0	-	-	-	-	-
	1 st credit	8,193	1,374	£0	£61,320	0	£43,329	0
	2 nd credit	6,770	2,797	£3,843	£116,372	0.6	£81,229	0.9
	3 rd credit	5,594	3,973	£13,361	£157,910	1.6	£107,872	2.5
	4 th credit	4,468	5,099	£18,244	£173,297	1.9	£117,239	3.1
	5 th credit	4,134	5,433	£96,364	£103,333	9.7	£44,874	42.9
High	Baseline	9,567	0	-	-	-	-	-
	1 st credit	8,193	1,374	£0	£150,650	0	£106,450	0
	2 nd credit	6,770	2,797	£3,843	£298,217	0.3	£209,721	0.4
	3 rd credit	5,594	3,973	£13,361	£416,212	0.6	£290,389	0.9
	4 th credit	4,468	5,099	£18,244	£504,805	0.7	£351,483	1
	5 th credit	4,134	5,433	£96,364	£456,556	3.5	£294,462	6.5

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BRE Global
Bucknalls Lane
Watford
United Kingdom
WD25 9XX

T + 44 (0)333 321 8811
E breeam@bregroup.com
www.breeam.com

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