3.0 BREEAM

BREEAM or Building Research Establishment's Environmental Assessment Method is a voluntary scheme that aims to quantify and reduce the environmental burdens of buildings by rewarding those designs that take positive steps to minimise their environmental impacts. Projects are assessed using a system of credits. The credits are grouped within the following categories:

- Management
- Health and Wellbeing
- Energy
- Transport
- Water
- Materials
- Waste
- Land Use and Ecology
- Pollution

The assessment process results in a report covering the issues assessed together with a formal certification giving a rating on a scale of UNCLASSIFIED, PASS, GOOD, VERY GOOD, EXCELLENT and OUTSTANDING.

The diagram and text below describe how BREEAM scores and rates an assessed building:

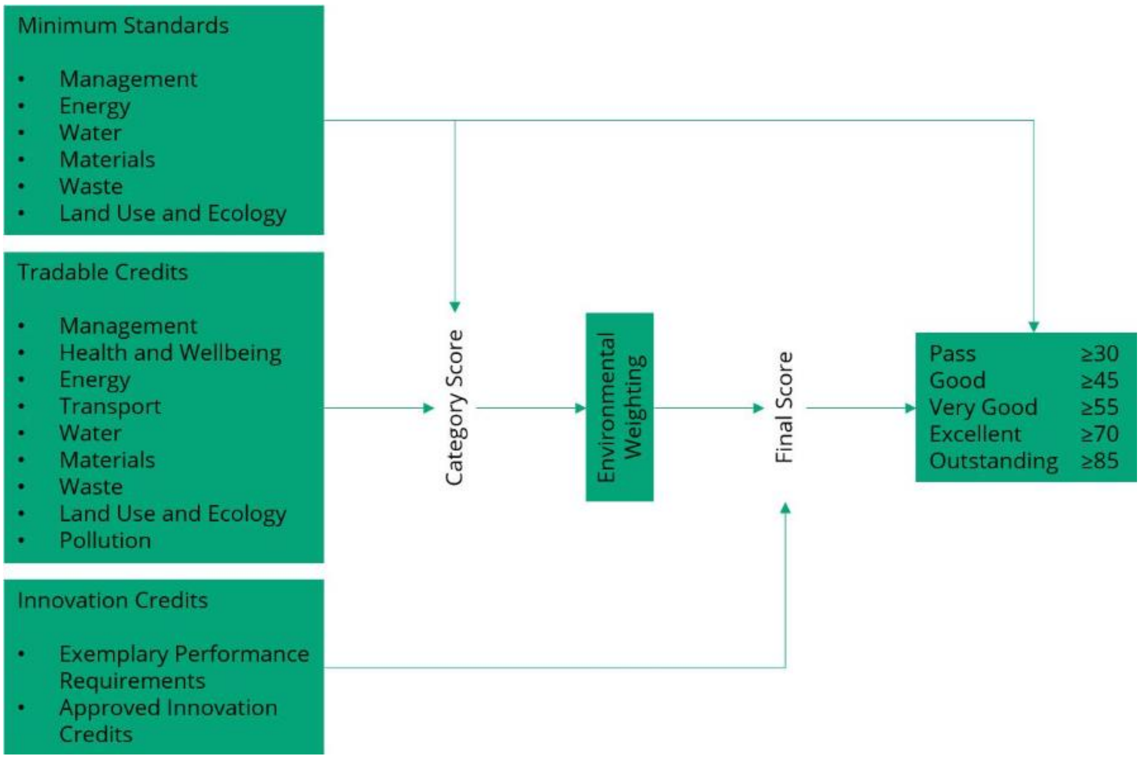


Figure 2 - Process for Awarding a BREEAM Rating

The BREEAM categories contain a number of environmental issues, which reflect the options available when designing, procuring and constructing a building.

Tradable Credits

Each environmental issue has a set number of 'credits' available and these credits are awarded where the building demonstrates that it complies with the requirements of that issue.

Minimum Standards

A number of issues within a category have set minimum standards, i.e. a minimum number of credits that must be achieved in order for a particular BREEAM rating level to be met.

Innovation Credits

Innovation credits provide additional recognition for a building that innovates in the field of sustainable performance, above and beyond the level that is currently recognised and rewarded by standard BREEAM issues. Innovation credits are awarded for either complying with pre-defined BREEAM issue exemplary level requirements, or via application to BRE Global to have a particular building feature, system or process recognised as 'innovative'.

Within each of the BREEAM categories outlined above, there are a number of credit requirements that reflect the options available to designers and managers of buildings.

An environmental weighting is applied to the scores achieved under each category, as shown below, in order to calculate the final BREEAM score. The weighting factors have been derived from consensus based research with various groups such as government, material suppliers and lobbyists. This research was carried out by BRE Global to establish the relative importance of each environmental issue.

The environmental weightings are as follows:

BREEAM Section	Weighting (%)
Management	11.0
Health and Wellbeing	8.0
Energy	14.0
Transport	11.5
Water	7.0
Materials	17.5
Waste	7.0
Land Use and Ecology	15.0
Pollution	9.0

Table 1 - BREEAM V6 New Construction Section Weighting

The BREEAM rating bands are as follows:

BREEAM Rating	Score (%)
UNCLASSIFIED	<30
PASS	≥30
GOOD	≥45
VERY GOOD	≥55
EXCELLENT	≥70
OUTSTANDING	≥85

Table 2 - BREEAM Rating Bands

4.0 Passive Design Analysis

In order to deliver an environmentally responsible building, an exemplar approach is being proposed based on low energy design principles. In summary, this approach involves energy demand minimisation through effective building form and orientation, good envelope design and proficient use of services; such that the building itself is being used as the primary environmental modifier.

Long term energy benefits are best realised by reducing the inherent energy demand of the building in the first instance. These benefits are described and quantified below.

4.1 Fundamentals

4.1.1 Building Location

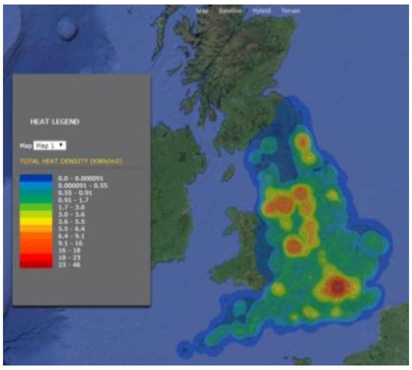


Figure 3 - DECC's National Heat Map

The location of a building can have a significant effect on energy consumption. Buildings located at higher altitudes for example, will be subject to colder external temperatures. Typically, the temperature drops 0.65ºC for every 100ft increase in altitude. Subsequently these buildings will have a greater heating demand than those closer to sea level.

Equally, the urban heat island effect means the ambient air temperature in built-up areas is greater than in more rural spaces. Buildings located in cities then, will have a lower heating demand in winter, but could require extra cooling in summer, as the effects of night purging are reduced.

4.1.2 Weather and Microclimate

The local weather and any microclimate will also influence energy usage. A development on the coast may have a maritime climate, experiencing milder winters and cooler summers than those further inland, particularly on the west coast where they are subject to the jet stream influence. Inland buildings will have a continental climate, suffering more extremes in temperature and therefore more likely to require heating and cooling.

A building in the south of the UK will also use more cooling than those further north, as the average temperatures in the south will be higher due to warm winds blowing from the tropics. The south coast of England is on average, 4˚C warmer than the north of Scotland. Those in the north then, will have a greater heating demand as they are subject to cold arctic air blowing in. These northern areas may also have a greater lighting demand, experiencing roughly 750 fewer daylight hours per year than the south coast.

4.1.3 Landscape

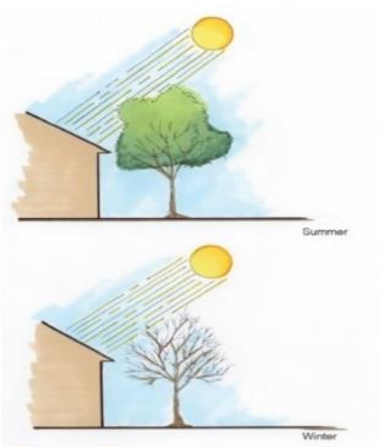


Figure 4 - Trees as Energy Conservation

The site's landscape also affects the energy demand of a building. Vegetation, landform and any existing buildings can provide shade to a new development. For example, if located to the south of the building, deciduous trees can be advantageous, providing shade in the summer but allowing sunshine through in the winter when they lose their leaves. However, any tree used for energy conservation should be considered as part of a much larger landscape.

The south-west part of the plot itself has car parking up to the boundary. The north-east and south-east boundary are due to be landscaped. The north-west side of the plot is composed of a service yard and HGV loading.

4.1.4 Building Use and Occupancy Type

Occupants, lighting, equipment and machinery within a building will emit sensible and latent heat. This excess heat can lead to an increase in the temperature and humidity within the space and can have a marked effect on the heating and cooling demands within a building. CIBSE Guide A provides typical values of internal heat gains for varying building types and activities.

Building type	Use	Density of occupation / person·m^{-2}	Sensible heat gain / W·m^{-2}			Latent heat gain / W·m^{-2}	
			People	Lighting*	Equip't†	People	Other
Offices	General	12	6.7	8–12	15	5	—
		16	5	8–12	12	4	—
	City centre	6	13.5	8–12	25	10	—
		10	8	8–12	18	6	—
	Trading/dealing	5	16	12–15	40+	12	—
	Call centre floor	5	16	8–12	60	12	—
	Meeting/conference	3	27	10–20	5	20	—
	IT rack rooms	0	0	8–12	200	0	—
Airports/stations‡	Airport concourse	0.83	75	12	5	4	—
	Check-in	0.83	75	12	5	50	—
	Gate lounge	0.83	75	15	5	50	—
	Customs /immigration	0.83	75	12	5	50	—
	Circulation spaces	10	9	12	5	6	—
Retail	Shopping malls	2–5	16–40	6	0	12–30	—
	Retail stores	5	16	25	5	12	—
	Food court	3	27	10	†	20	§
	Supermarkets	5	16	12	†	12	§
	Department stores:						
	— jewellery	10	8	55	5	6	—
	— fashion	10	8	25	5	6	—
	— lighting	10	8	200	5	6	—
	— china/glass	10	8	32	5	6	—
	— perfumery	10	8	45	5	6	—
	— other	10	8	22	5	6	—

Building type	Use	Density of occupation / person·m^{-2}	Sensible heat gain / W·m^{-2}			Latent heat gain / W·m^{-2}	
			People	Lighting*	Equip't†	People	Other
Education	Lecture theatres	1.2	67	12	2	50	—
	Teaching spaces	1.5	53	12	10	40	—
	Seminar rooms	3	27	12	5	20	—
Hospitals	Wards	14	57	9	3	4.3	—
	Treatment rooms	10	8	15	3	6	—
	Operating theatres	5	16	25	60	12	—
Leisure	Hotel reception	4	20	10–20	5	15	—
	Banquet/conference	1.2	67	10–20	3	50	—
	Restaurant/dining	3	27	10–20	5	20	—
	Bars/lounges	3	27	10–20	5	20	—

Figure 5 - Benchmark Allowances for Internal Heat Gains in Typical Buildings Taken from CIBSE Guide A

Latent heat results in an instantaneous addition of moisture to the air, so there is no cooling load factor associated with it. Sensible heat, however, is absorbed by the surrounding surfaces and radiated more slowly into the building.

The internal heat gains will vary depending on a room or building's use. There will be a greater heat gain from occupants participating in exercise at a gym, for example, than those in an office, sat working on a computer. However, the computers and associated equipment will be adding additional heat to the office which would not be present at the gym. Equally, the lighting requirements will be different in each building, and the heat gains will be dependent upon the lamp, luminaire, and location of the fitting. Subsequently, internal heat gains need to be considered as a whole.

The Symmetry Park Bicester Phase 3, Unit E will comprise a large space for distribution with main 2-storey office to the south-west side of the plot.

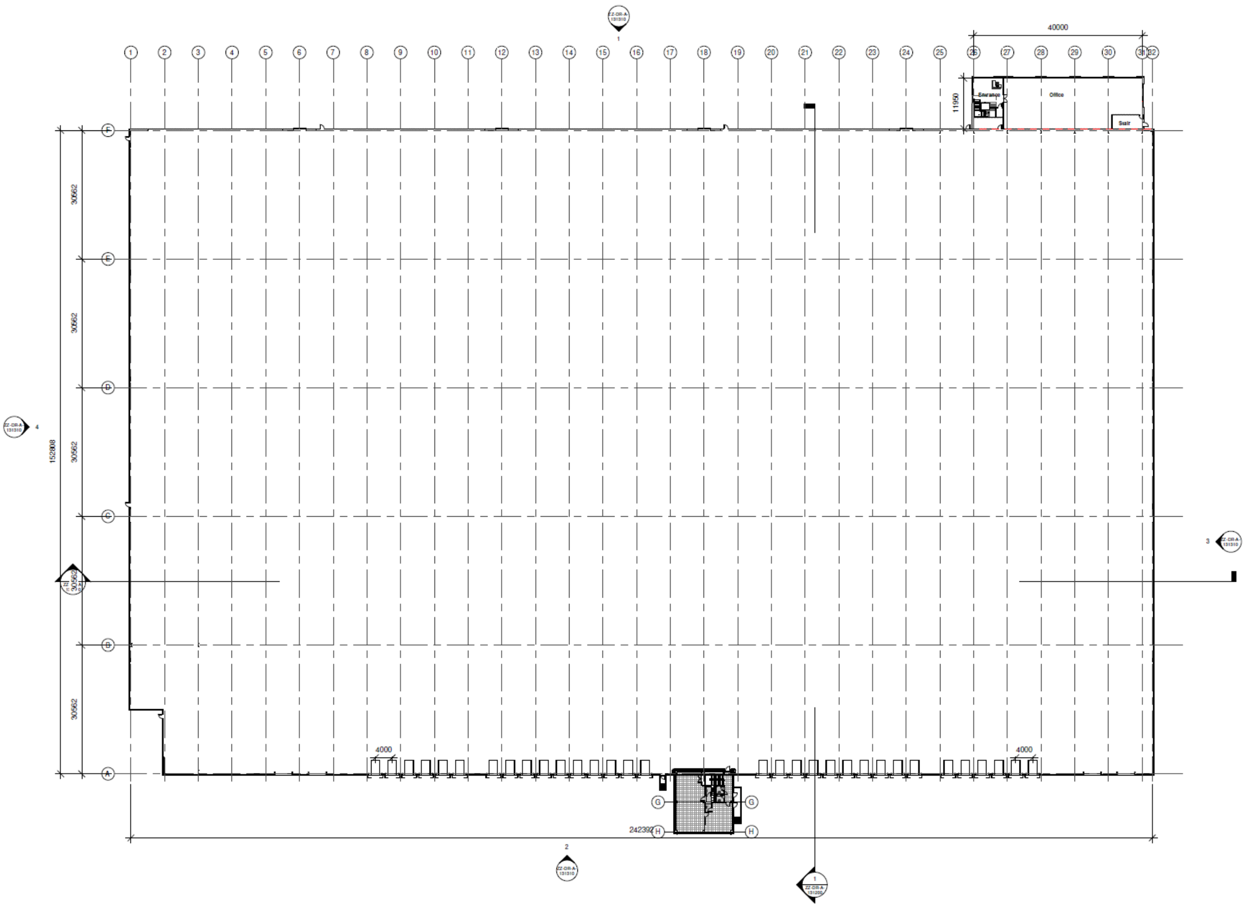


Figure 6 – Symmetry Park Bicester Phase 3, Unit E - *Warehouse and Office Plans*

Typically, the warehouse and office will have the greatest occupancy for several hours at a time, while reception/lobby areas will have periods of high occupation as people move in and out of the building. These areas will have limited equipment and due to good daylight factors, internal heat gains will be low.

4.1.5 Building Layout, Orientation and Form

Building layout, orientation and form can influence many key features of the development. The design should provide for an effective use of space and appealing layout, with opportunities to benefit from natural daylight balanced with achieving solar gain without overheating. In general, a higher thermal performance can be achieved by limiting the surface area to volume ratio as this minimises heat loss through the wall area.

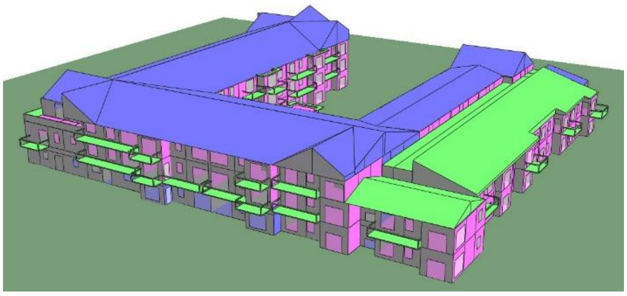


Figure 7 - Schematic Diagram of a Typical Building Layout

By orientating the building, so that the long sides of the building face north and south, glare arising from the low early morning and evening sun is designed out. It should be noted that where the building footprint is extremely tight, for example in a city centre location, then the building form and orientation may have to be dictated by the available space and not by implementation of best practice measures. Invariably, planning constraints and/or the functional relationships of specific areas will result in some measure of deep planning, thus reducing the opportunity for natural ventilation.

Solar heating or solar gain is often welcome in winter months, helping to heat up the building. However, careful design and attention to building orientation is essential to avoid summertime overheating, as on a clear day in summer an unshaded window in the UK can admit 3kWhr of energy per m^2 of glass. Overheating is likely to be more of a problem if the windows face the southern half of the sky (east or west facing windows can also be a problem in some types of building), there are horizontal or near-horizontal rooflights, the building has high internal heat gains or the building needs to be kept cooler than normal.

Planning the internal layout of buildings and rooms to maximise the benefits of solar gain and minimise the disadvantages is essential. Spaces where overheating would be critical can be placed on the north side of the building or overhangs used to protect from excessive solar gain.

The main offices will face south-west side towards the car park. Low material U-values and solar protection on the glazing will mean that there will be minimal overheating in the summer, which is essential as the offices experience the greatest amount of overheating. Roof lights will be incorporated into the warehouse to allow good daylight and some solar gain.

4.2 Building Envelope

4.2.1 Building Fabric Thermal Performance

The use of building materials with high grade thermal performance (low U-values) is vital to reducing the energy consumption and CO_2 emissions within any development.

The insulation of the building envelope will need to be better than the limiting values required under the current (2021 Edition) Part L Building Regulations. The limiting values, prescribed within the regulations, are the minimum acceptable levels of insulation for each element of the construction.

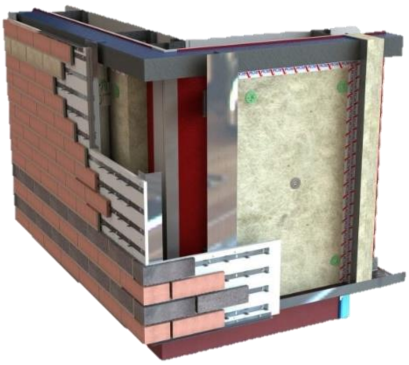


Figure 8 - Schematic of Typical Building Elements

The benefit of any U-value reduction, in terms of energy/CO_2 saving, can quickly be ascertained using dynamic modelling software. This tool can also be used to help determine the optimum selection of materials against cost.

The building envelope should be designed to ensure that the fabric and form of the spaces encompass the low energy sustainability principles necessary to target a BREEAM 'Very Good' rating. Fabric thermal transmittance values for the walls, floors and roof of the building will need to achieve excellent standards to meet the carbon reductions that will be targeted as part of the BREEAM 'Very Good' agenda.

For the Symmetry Park Bicester Phase 3, Unit E, improvements on the minimum values are proposed to minimise operational energy demand and further exceed Part L requirements (see table below). It should be noted that high grade (low U-value) materials tend to attract a cost premium.

The following table describes the proposed minimum building envelope thermal performance criteria.

Element	Part L 2021 Building Regulations (Notional)	Target Criteria Value	Notes
Roof 'U' Value	$0.18W/m^2K$ (flat roof) $0.16W/m^2K$ (pitched roof)	$0.16W/m^2K$	No pitched roofs in the building

External Wall 'U' Value	0.26W/m²K	0.17W/m²K	
Ground Floor 'U' Value	0.18W/m²K	0.18W/m²K	Applicable to both ground bearing and supported slab
External Glazing 'U' Value	1.6W/m²K	1.6W/m²K	Glass to achieve a total light transmission of Lt = 0.65 (G = 0.45)
External Glazing 'G' Value		0.45	Solar gain transmission value
External Glazing 'Lt' Value		0.65	Light transmission value
Vehicle Access Door 'U' Value	1.3W/m²K	1.3W/m²K	Including frames and installation
Personnel Door 'U' value	1.6W/m²K	1.6W/m²/K	
Roof Light – Atrium Type 'U' Value	2.2W/m²K	2.2W/m²K	Glass to achieve a total light transmission of Lt = 0.65 (G = 0.45)
Air-permeability	8m³/hour/m² @ 50Pa	3m³/hour/m² @ 50Pa	
Thermal Bridging (ψ) Value (W/mK)		Consider and limit where possible	
Mechanical Ventilation Heat Recovery Device Efficiency		80%	

Table 3 - Summary of Building Envelope Thermal Performance Criteria

4.2.2 Air Permeability

The air tightness of a building impacts on its energy consumption and hence the CO_2 emissions. The more airtight the building, the less energy is required to heat the building in winter. Part L2 of the current (2021 Edition) Building Regulations states that air permeability must be less than 8m³/hr per m² @ 50Pa. Experience working with the new regulations has shown that it is usually necessary to make significant improvements on the statutory limit to achieve CO_2 emission compliance. A new build development should target a value of 3-5m³/hr per m² @ 50Pa.

In accordance with the requirements of a low energy building, the air tightness characteristics will be addressed. With robust design, the target proposed for the building is $3m^3/m^2/hr$ @ 50Pa. This represents an improvement over the current Part L Building Regulations standard of 62.5%.

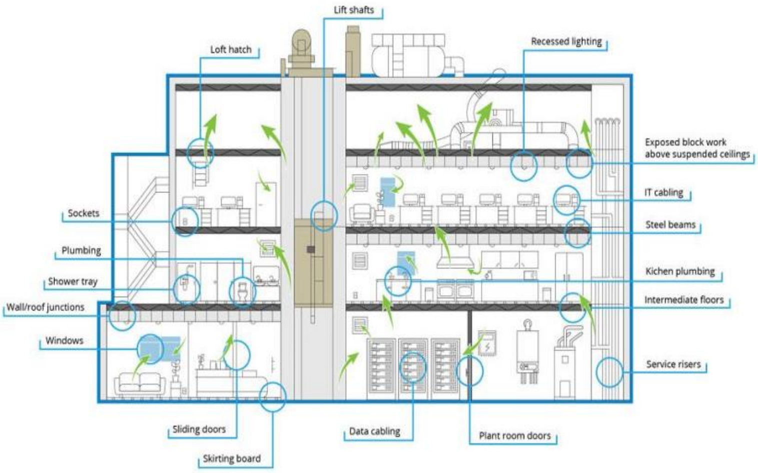


Figure 9 – Potential Air Transmission Paths

4.2.3 Heavyweight Structure (Thermal Mass)

The use of heavyweight building materials in determined areas of a construction can provide thermal mass and inertia which will help regulate the internal temperature and reduce the risk of overheating. Heavyweight roof structure and block walls are elements where thermal mass can be concentrated. Exposed concrete, for example, has a high density and specific heat capacity and can absorb heat generated by occupants, equipment, lighting and through solar gain during the day.

At night, the exposed concrete can be cooled through a combination of natural and/or mechanical means. This night purging facilitates the storing of 'coolth' by the heavyweight fabric which can be released the following day.

Research has shown that a heavyweight building can maintain room temperatures circa 2ºC - 4ºC below outside temperatures, whereas lightweight buildings are typically 2ºC - 4ºC above outside temperatures.

Figure 10 - Cut-away of Heavyweight Structure (Thermal Mass)

It should be noted that there are aesthetic issues associated with exposing the thermal mass and services but the main concerns are with acoustic performance. Hard surfaces promote the reflection of noise through a building, reducing privacy. Acoustically absorbent tiles, strategically suspended below part of the exposed concrete ceiling, can be used to overcome this problem.

For a BREEAM development, a highly sustainable, low impact building utilising 'A-rated' materials (as defined in 'The Green Guide') is sought. Due to the vast amount of energy needed to produce the ingredients (e.g. cement) for concrete, during the processing phase known as calcination, concrete is not classed as an 'A-rated' material.

An alternative product that offers all the benefits of a heavyweight construction material, but without the energy burden of concrete is Hempcrete. Hempcrete is a bio-composite building material comprising a blend of specially prepared hemp shiv (the processed woody core of the plant) and a lime based binder. The hemp, which forms a key element of the product is grown and harvested in the UK. Hempcrete can help reverse the damaging effects of greenhouse gases by locking up harmful CO_2 emissions within wall construction whilst delivering high levels of insulation, air tightness and vapour permeability. It is normally spray applied on-site using a shuttering system to create the cast in-situ walling.

Figure 11 - Blockwork innerleaf, brick work outerleaf cavity wall with basalt wall ties

A further sustainable option for heavyweight wall construction is the use of rammed earth, also known as cob. This is an age-old building method that has seen revival in recent years as developers seek natural building methods. Using it involves a process of compressing a damp mixture of earth, that has suitable proportions of sand gravel and clay (sometimes with an added stabilizer), into an externally supported frame that moulds the shape of a wall section creating a solid wall of earth. After compressing the earth, the support frames can be removed for the structure to dry and harden. The construction can take up to two years to completely cure. An example of a rammed earth wall construction can be seen at the entrance to the Eden Project in Cornwall.

The Symmetry Park Bicester Phase 3, Unit E, will incorporate thermal mass into the concrete slab.

4.2.4 Daylighting and Glazing

4.2.4.1 Daylight

A typical working environment should be illuminated to a light level of 300 - 500 lux, and for approximately 70% of the working year, 10,000 lux is available externally from an overcast diffuse sky. Therefore, through effective window and façade design, as well as strategically located atria and light wells, light can be brought into a building, and artificial lighting within rooms can be dimmed or switched off, saving energy.

The amount of daylight within a room can be represented as a percentage of the available external daylight. BREEAM credit Hea 01 suggests this daylight factor should be a minimum of 2-3%, dependant on a room's function, in order for lights to be dimmed. However, even if dimmed to 1% artificial lighting will still typically consume 20% energy. Therefore, other industry publications such as CIBSE Lighting Guide 10 recommend daylight factors above 5%, as this would mean there is enough light in the room to allow artificial lighting to be switched off altogether.

Figure 12 - Effective Daylighting in a Working Environment

Increasing daylight factors is achieved through careful design and consideration of the window size and position. Rooms with high window head heights enable daylight to penetrate deeper into the room, whereas full height windows to the floor encourage very high daylight factors adjacent to them, spoiling the uniformity across the room. Too much or badly positioned glazing can also cause excessive glare and result in building users closing the blinds and turning on the artificial lights.

Rooflights and sun pipes can be used to channel daylight into central areas and corridors, and rooms with inner walls facing into an atria can have secondary daylight brought in through internal windows, improving the uniformity of illumination.

Daylight factor and uniformity ratio are important measures of daylight provision for the Symmetry Park Bicester Phase 3, Unit E. High levels of natural daylight will be provided, wherever possible, through effective window design, for example by utilising 10% rooflights to the warehouse area.

4.2.4.2 Glazing

The choice of glazing affects the daylight, heat loss and, importantly for a naturally ventilated building, the solar heat gain through a window. The optimum glazing area for saving energy is around 30% - 50% (varying with orientation and type of glazing), as overheating is a risk with areas greater than 50%.

A wide variety of solar control glazing is available to combat overheating, including absorbing glass which is body tinted, reflective glass which has a special coating, and prismatic glass which can reflect and refract incoming sunlight. There is also the option of a combination of solar photovoltaics (PV) and glass, where PV cells are laminated between two panes of specialised glazing. The resulting glass laminate serves the dual function of creating energy and shade at the same time.

Figure 13 - Solar Glazing

The main office glazed area is concentrated on the south-west side of the building. This increases the chances of overheating in the offices and allows the greatest amount of natural light into the rooms which will be occupied for the longest period.

Glazing should be specified following careful consideration of the Solar Energy (G-value) and light transmittance values. Higher G-values will be welcome in winter, in order to benefit from as much solar heat gain as possible, but could lead to overheating in summer, especially when the U-Values are low.

Good light transmittance is required all year round so as to minimise the use of artificial light. However, as the g-value decreases, so does the light transmittance. It is possible to achieve low g-values whilst maintaining high light transmittance, but this can get expensive. Therefore, a compromise is needed between the two values.

The glazing specification should ensure performance criteria for light transmission (Lt Value) of not less than 0.65 with a combined low solar transmission (G value not greater than 0.37) to protect against solar gain to mitigate effects of summertime overheating.

Encouraging the correct quality and quantity of daylight to penetrate the building is key to reducing the amount of light required from artificial sources and hence energy requirements. The table below gives target figures which have been calculated to allow the optimal daylight into the Symmetry Park Bicester Phase 3, Unit E, without risking too much summertime overheating.

Element	Targeted Value
External Glazing 'G' Value	0.45
External Glazing 'Lt' Value	0.65

Table 4 – External Glazing 'G' and 'Lt' values

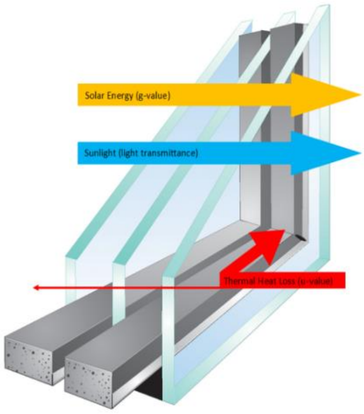


Figure 14 – Glazing Specification Parameters

4.2.5 Solar Shading

Façade engineering or solar shading can be a highly effective way of controlling overheating and help reduce glare. Techniques may include external, internal or mid-pane shading devices, or solar control glazing.

Figure 15 - Solar Shading at Project Epic

External shading is generally the most effective of these, as it intercepts the solar radiation before it enters the building such that very little solar gain is transmitted to the occupied rooms. (Overhangs and other projections are similarly effective).

Horizontal shades are more effective on south facing facades that receive the most sunlight, but vertical shades are better for those that face east and west when the sun is low in the sky. North facing windows receive sunlight only in the early morning or evening in summer so shading is generally not required.

It should be noted that all shading devices will block some daylight and affect the occupants view out, so some sort of compromise is needed.

In some cases, it may be possible to use solar louvres as shading devices on the south façade; a technique whereby solar photovoltaic panels are incorporated into the brise soleil itself (see below).

For the Symmetry Park Bicester Phase 3, Unit E, brise soleil could be incorporated in the main office at a later stage. Initial modelling shows that the office areas are susceptible to overheating.

Figure 16 - Solar Louvres

4.3 Mechanical and Electrical Services

4.3.1 Ventilation Strategy

Adopting the correct ventilation principle is critical to the success of the project. The provision of mechanical ventilation is a significant consumer of electrical energy within the building, therefore natural ventilation systems are encouraged. However, mechanical ventilation will be needed within any spaces that are acoustically or clinically sensitive, have occupancy or internal gains e.g. from IT, as well as any that have a sealed fenestration system to reduce or negate external noise from traffic or other sources. Therefore, a mixed mode approach should be taken.

Carefully designed ventilation systems combined with high thermal mass construction, can significantly reduce summertime temperatures and prevent overheating. Natural ventilation can reduce summertime cooling demands, whilst including heat recovery within mechanical systems can help reduce winter heating costs.

4.3.1.1 Natural Ventilation

Adopting natural ventilation systems (openable windows, atria, ventilation stacks) will reduce the dependence on mechanical air handling systems as well as providing a pleasant working environment. In general, low occupancy areas (e.g. office space with 1 person per $10m^2$ - $12m^2$) lend themselves to a natural ventilation strategy with room depths of up to circa 7.0m. It should be noted however, that the performance of natural ventilation is highly dependent on the forces of nature.

Figure 17 - Openable Windows

There are two forces driving natural ventilation. Tall rooms and atria can take advantage of the "Stack Effect", whereby warm air rises within the building and exits via high level windows or rooflights. This draws in air cooler air entering at lower-level windows or doors.

Double sided and shallow plan rooms can take advantage of wind forces, applying cross ventilation from window to window. This is the most effective arrangement for providing ventilation (in winter) and cooling in summer.

Single sided room ventilation can also prove effective up to depths of circa 2.5 times the height of the room – giving a maximum depth of 7.5m for a 3.0m high space. This is particularly advantageous in areas which would be exposed to external noise levels e.g. traffic noise, through the opening of windows.

4.3.1.2 Hybrid Heat Recovery Ventilation

Natural ventilation can be used to good effect in spring and summer. In winter however, the use of natural ventilation in the form of openable windows can lead to an increase in heat loss. Using a mixed mode system where mechanical ventilation is used in the winter, minimises heat losses to the environment and despite the additional electrical energy requirements, an overall reduction in CO_2 emissions can be achieved.

The CO_2 emissions from using mechanical ventilation can be minimised, if the internal heat gained can be utilised through heat recovery, rather than being extracted to atmosphere via the windows or ventilation system.

A mechanical ventilation heat recovery unit (MVHR) passes the warm outgoing 'exhaust' air stream through a heat exchanger (generally thermal wheel, plate heat exchanger or run-around coil) where some of the thermal energy is transferred to the cold incoming 'supply' air. This reduces the amount of heat needed to be added to the supply air, often to the point where no additional heat is required.

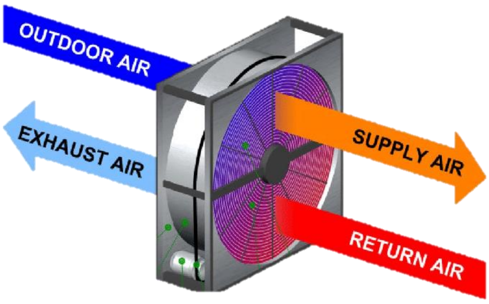


Figure 18 - Thermal Wheel

The benefits of a hybrid ventilation system utilising a mixed mode system with MVHR, are more than just with CO_2 savings. Several reports, including the BRE 'Ventilation and Indoor Air Quality in Schools – Guidance report 202825' May 2006, have been produced addressing ventilation principles. The report confirms that natural ventilation is seldom used in winter due to low temperatures and cold draughts, and that the subsequent poor ventilation reduces the indoor air quality (IAQ) which significantly reduces occupant concentration and performance.

For the Symmetry Park Bicester Phase 3, Unit E, a hybrid ventilation system has been proposed for the offices. This will allow natural ventilation to be employed in the offices whenever possible, so as to reduce everyday demand, with a mechanical system for use in the winter.

4.3.2 High Efficiency Motors

Fan and pump motor loads should always be minimised by good system design prior to motor selection. High-efficiency inverter-controlled fan and pump motors should be employed to facilitate accurate commissioning and reduced energy consumption at part load conditions. This will ensure that plant output characteristics match system pressure drops. Direct drives rather than belt drives should be encouraged where practical. The use of Variable Speed Drives (VSDs) should always be considered for efficient system regulation and variable flow control. Systems should be carefully designed to minimise pressure loss and hence reduce energy consumption.

Where fan systems are installed in the Symmetry Park Bicester Phase 3, Unit E, the systems shall be designed to limit the specific fan power at the design flow rate to the following values:

System Type	SFP (W/(litre/sec))
Central mechanical ventilation including heating, cooling and heat recovery	2.5
Central mechanical ventilation including heating and cooling	2.0
All other central systems	1.8
Local ventilation only units within local area, such as window/wall/roof units, serving one room or area	0.5
Local ventilation only units remote from the area such as ceiling void or roof mounted units, serving one room or area including VAV units	1.2
Other local units, e.g. fan coil units (rating weighted average)	0.8

Table 5- Limiting Specific Fan Powers in New Buildings

4.3.3 Artificial Lighting

Electric artificial lighting is often the single largest end-use of energy within buildings and can account for over 40% of the total electricity costs. When artificial lighting is used, it not only consumes electrical energy but adds to the internal heat gains, which can give rise to a situation where additional electrical energy is required to cool certain spaces. It is imperative then, that the lighting design philosophy provides the correct quality of lighting with minimum energy input and hence reduces internal heat gains.

To this end, the first key approach is not necessarily reducing the quantity of installed products but ensuring that systems are used less, and emit as much artificial light as possible, when operational, to minimise energy consumption. This can be achieved by using highly efficient dimmable luminaires. Simple advancements in optical systems within luminaires, such as louvre material and design have increased product output performance.

Output performance or Light Output Ratios (LORs) is the percentage of the light produced by the lamp which actually exits the luminaire as useful light. Dimmable luminaires which offer high LORs (>85%) should be considered, as these can reduce energy consumption even further. Choosing lamps that have high outputs compared to energy used is also important here. Artificial lighting should be designed to an average initial efficacy of not less than 60-65 luminaire-lumens/circuit Watt as averaged over the whole area in the building. LED light sources can typically produce over 100lm/W, and this efficiency will only improve over the coming years.

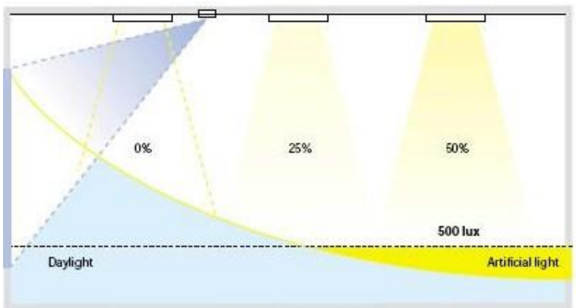


Figure 19 – Daylight sensors can allow lights to be dimmed by certain percentages depending on available daylight

Lighting control should adopt a daylight sensing approach combined with occupancy detection, where applicable. With the correct amount of daylight entering a space, it is possible to ensure that the luminaires are used as infrequently as possible. Sensors to dim lighting systems should be employed such that an installed system can be dimmed to a set level. Sensors incorporating photocell technology will allow dimming control of carefully selected luminaires where daylight contribution could facilitate energy savings.

Occupancy or absence detection is an energy saving strategy that controls the lighting status depending on whether a room has been vacant for a set period of time. The function of the room and occupancy profile should be carefully considered in terms of frequency of switching. Certain lamp types will fail early if switched too frequently (>8 switching's per day).

Artificial lighting strategies involve various mounting types such as recessed, pendant, wall etc. It is important that the lighting strategy provides the functional lighting quality and quantity to enable a user to perform the required task. At the same time, the illumination of other room surfaces is important to create an environment that is not depressive and one that stimulates the working environment.

Suspended pendant luminaires offer the advantage of providing additional light upwards onto the ceiling and in providing a continuous system where cabling and accessories are concealed. These systems tend to work best with exposed soffit ceilings and due to their ability to conceal wiring and services on the ceiling.

It is imperative that the lighting design philosophy for the Symmetry Park Bicester Phase 3, Unit E, provides the correct quality of lighting with minimum energy input and internal heat gains. High efficiency LED products will be used throughout the project. Lighting control systems will include daylight sensing and absence detection to ensure that the electrical energy and associated carbon emissions of the building lighting installation are kept to a minimum. Output performance or Light Output Ratios (LORs) will exceed 80%.

4.3.4 Building Management System (BMS)

A Building Management System (BMS) is a computer based centralised system that helps manage, control and monitor engineering services and equipment installed in a building. This equipment can include heating, ventilation, cooling, security, and lighting. The BMS has evolved from being a simple supervisory controller, to a totally integrated computerised control and monitoring system. BMS installations can include energy monitoring facilities that will allow the performance of the building, and its associated energy use, to be monitored accurately and consistently.

For the Symmetry Park Bicester Phase 3, Unit E, as well as being used to control services, the BMS could be utilised to collate metering data and identify irregularities in energy consumption (effectively a Building Energy Management System [BEMS]). This information could then be used to provide a meaningful input for the purposes of energy management for energy/CO_2 savings.

To promote energy efficient operation of the Symmetry Park Bicester Phase 3, Unit E, and to demonstrate the building's 'green credentials', the energy consumption could be relayed to a LCD/plasma screen, perhaps in the lobby area. This would ensure occupants are conscious of the positive impact that the passive design solutions and possible renewable technologies are making on the CO_2 footprint of the development.

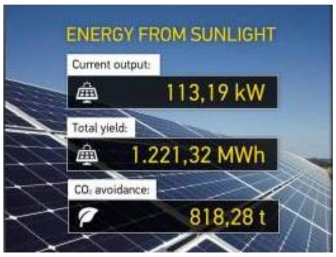


Figure 20 – Display of Energy Produced by Solar Panels

5.0 Adaption to Climate Change

UK Climate Change Risk Assessment 2022

Since the 1970s, average temperatures for Central England have risen by nearly 1°C, and the last decade was the warmest on record. It is likely that the climate will continue to change with higher temperatures, changing rainfall patterns, rising sea levels and more unpredictable extreme weather ranging from floods, droughts and freezing winters. The UK Climate Change Risk Assessment: Government Report (2022) outlines the risks faced to businesses, buildings, and health and wellbeing in the future.

Risks noted within this report include the likelihood of increased external temperatures, which could lead to overheating in buildings as UK temperatures increase and heatwaves become more common. As well as risk to life, high temperatures will lead to productivity losses for UK workers., and damage to equipment due to high internal building temperatures. Increased external temperatures would also lead to increased energy demand for cooling, which would not only further increase atmospheric carbon emissions, but also put strain on the energy infrastructure. Energy infrastructure itself would also be at risk of disruption, meaning that there will be less energy available on the grid.

Passive design features of the Symmetry Park Bicester Phase 3, Unit E, mean that the building is well adapted to these risks. Firstly, the energy demand has been reduced, resulting in the building being less affected by the decreased availability of energy. Secondly, the development will have a lower carbon footprint, helping prevent further contributions to climate change.

A combination of the expected increase in external temperatures and the extensive glazing to the office areas could potentially put the building at risk of overheating. However, a number of features have been included within the building design to prevent this.

Efficient lighting and mechanical systems will keep the Symmetry Park Bicester Phase 3, Unit E's internal heat gains to a minimum. High performing U-values and designing out thermal bridges will retain heat within the building. This also means that heat cannot enter the building through the fabric. High thermal mass will absorb much of the heat that is present within rooms, keeping the room below external temperatures.

These features, in addition to the incorporation of some natural ventilation, will mean that there will be lower demand for cooling, keeping the building's energy demand low.

This combination of passive design measures will act to stabilise the temperatures within the building and enable it to adapt to any temperature extremes.

6.0 Summary and Conclusions

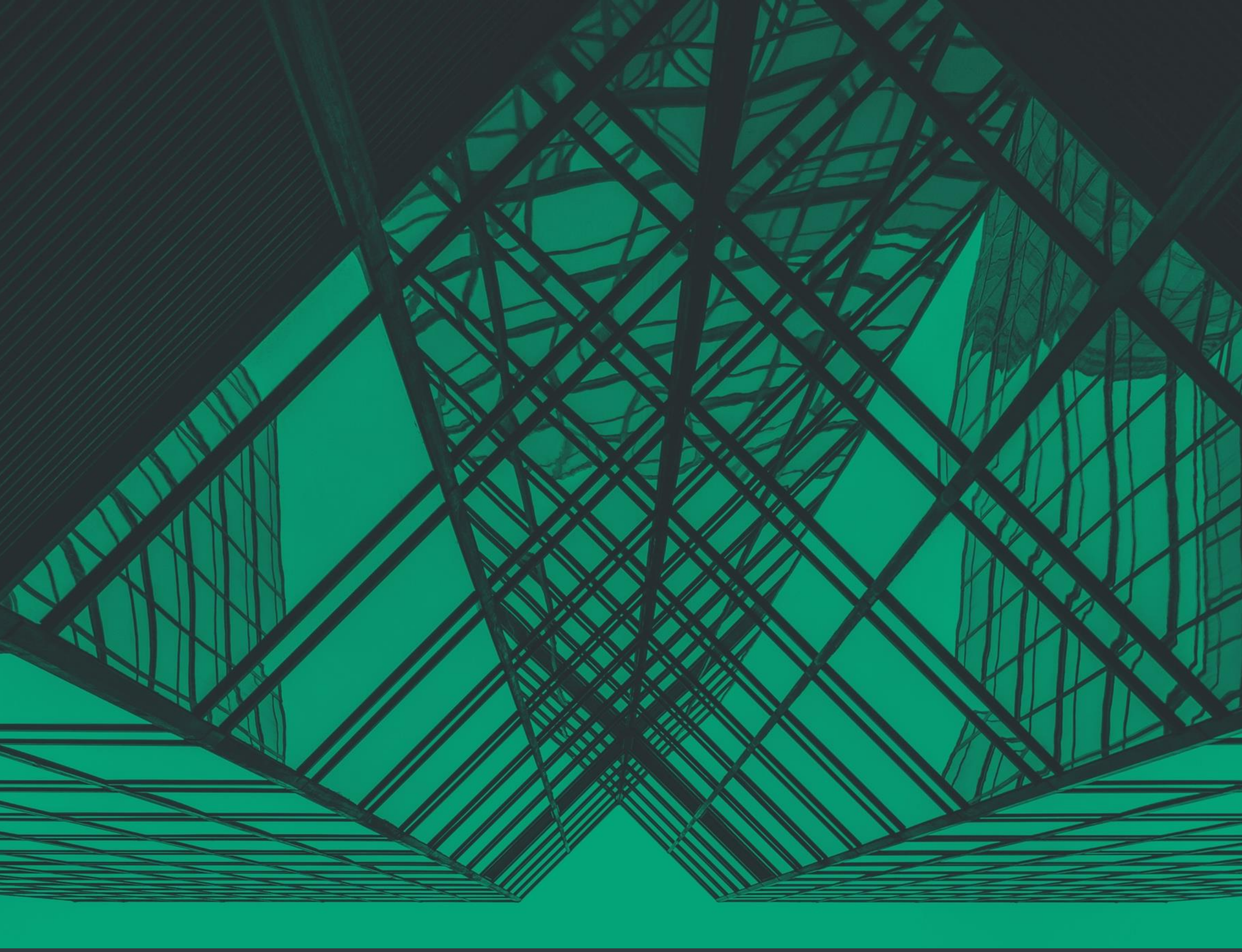
A Passive Design Analysis has been undertaken on the proposed Symmetry Park Bicester Phase 3, Unit E, to summarise the passive design features incorporated into the building.

In order to deliver an environmentally responsible building, an exemplar approach is being proposed, based on low energy design principles. In summary, this approach involves energy demand minimisation through effective building form and orientation, good envelope design and proficient use of services; such that the building itself is being used as the primary environmental modifier.

It has been shown via accredited computer modelling that, by incorporating the above best practice energy efficiency measures alone, results in a reduction in energy requirements and CO_2 emissions compared to a notional building of **5.0%** and **0.4%** respectively.

The total predicted regulated building energy consumption is: **244,205kWhr per year**

The total predicted regulated building CO_2 emissions are: **34,930kgCO_2 per year**



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211272

Feasibility Report for BREEAM
Passive Design Options

Sustainability at our core.

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