B&NES Sustainable Building Standards Study

Rev D – Final Issue

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1. INTRODUCTION

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1.1 Purpose and Scope of the Study

Following on from Bath and North East Somerset (B&NES) experience on commissioning and procuring their new head quarter offices at Keynsham Civic Centre, the Council is planning a number of new build development projects, including offices, residential buildings, schools and operational buildings. This study aims to capture the options and opportunities for setting sustainability standards on these new developments. It provides an evidence base and toolkit for the Council's Approach for Health & Sustainability in the Council's New Build Projects, which in turn helps deliver the Council's 2020 Vision and objectives around sustainability, economic development and wellbeing.

The Council will not be owner occupier in many of its new buildings, and each delivery route may well be different. With this in mind, the Council commissioned the study to address three points:

1. **Provide information on the range of available sustainability standards that are relevant for BANES Council new build projects**
2. **Address how B&NES Council manages projects to ensure the aspirations are achieved**
3. **Provide guidance on sustainability principles for B&NES' future development projects**

The options put forward are to inform a discussion about what sustainability standards or requirements to include in construction briefs on new build projects and how projects should be set up for success. Standards are defined as certification routes, metrics or verifiable approaches to achieving low energy in-use, healthy and climate-resilient buildings of various types.

In addition to providing case studies of sustainable buildings, the study will provide case study examples of management, procedures and contractual arrangements that can help achieve and deliver the sustainability standards that have been set. Whilst the study primarily focuses on new build projects, it will also include a guide of top ten principles to be included in future schools projects and examples of sustainable refurbishment of historic buildings, of which there are many in Bath and North East Somerset.

1.2 The Council's Approach for Health & Sustainability in the Council's New Build Projects

Bath and North East Somerset Council: 2020 Vision
'*Bath and North East Somerset will be internationally renowned as a beautifully inventive and entrepreneurial 21st century place with a strong social purpose and a spirit of wellbeing, where everyone is invited to think big – a 'connected' area ready to create an extraordinary legacy for future generations*'

Rationale for Sustainable Buildings
Sustainability, health and wellbeing are central to realising our 2020 vision. The Council's own building projects can exemplify this, helping to achieve our aim of reducing our area's CO2 emissions 45% by 2026 and providing high quality, healthy buildings that are enjoyable to inhabit, affordable to run and fit for the future. These buildings will support our broader aims of improving wellbeing and our local economy.

We are already national leaders in sustainable construction. Our award-winning Keynsham Civic Centre proved that a high level of sustainability can be achieved at no extra build cost. This learning will be carried forward into all of our new building projects, whether they are for the commercial market or for the public sector.

Our Principles
Our approach will consider energy, health and the future climate. For each of these elements, detailed targets will be set depending on the characteristics of at each project, following the principles below:

Energy: At Keynsham, a fabric-first approach using passive design principles and renewable energy has reduced our energy bills from c.£180,000/yr in the Riverside office to c.£8000/yr.

- Energy Standard: Keynsham Civic Centre was designed to meet a Display Energy Certificate rating of "A". We will develop targets for our other building projects that will meet or exceed this level of ambition where possible.
- Energy Strategy: Simplicity, Performance and Renewables: We will optimise building designs, focus on fabric and ensure a high build quality to address the energy "performance gap", ensuring that our buildings perform as well as expected once they are occupied. Simplicity is crucial; we will create buildings that are intuitive for occupants to operate and maintain. We will demonstrate that through careful design, renewables can complement our outstanding natural and historic environment.

Health: The Bath and North East Somerset Corporate Strategy (2016- 2020) has "Prevent" as one of four key areas of focus:

"Over the next four years we will increasingly need to invest in a range of new approaches that enable people to live well and independently…that help people to be safe and that prevent or delay the onset of ill health. We will also need to act to address the impacts of climate change. For many years the focus has been on caring for people when they are ill rather than on keeping them healthy. Changes in our local population – people are living longer with more complex conditions, some of which are avoidable – means that this is no longer financially sustainable".

People now spend around 90% of their time indoors. Building health is increasingly recognised as the next frontier for healthy living. We will create buildings that have clean, fresh air; light and daylight; thermal and acoustic comfort; food growing opportunities and access to biodiverse nature. Active lifestyles and sustainable transport will also be enabled by the building design. The diagram below summarises research into the value of healthy buildings:

Climate Ready: The buildings we create today will have to perform under very different conditions in the future. Climate projections for our local area show that summers are likely to be 2.5 to 3.2°C warmer by 2050. Overheating affects productivity in an office environment and can affect the health of residents. Vulnerable inhabitants such as elderly people and children are particularly at risk. Extreme weather is also likely to become more frequent, for example drought, heatwaves, severe storms and heavy rainfall. We will design buildings that will perform well and retain their value in the future climate.

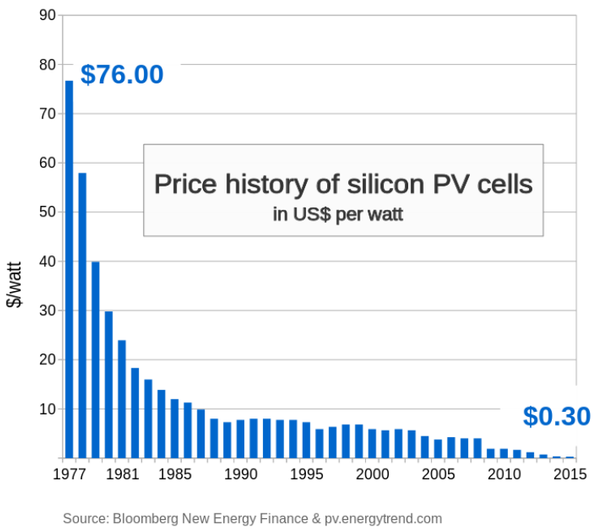
2.0 FINANCIAL CONSIDERSTAIONS FOR SUSTAINABLE CONSTRUCTION

2.1 Introduction

The capital cost of sustainable construction is falling, and sustainability is increasingly valued by property investors as an indication of building quality and longevity. Sustainability in buildings centres around the effective and wise use and deployment of resources. Therefore sustainable buildings can be demonstrably cheaper to run, both in terms of energy costs and maintenance. However, there are also a wide array of benefits derived from well-designed buildings which maximise the wellbeing of their occupants. These benefits may translate into better staff retention in offices, increased productivity, less absenteeism through ill health and the corresponding profitability that follows these trends. See Derek Quilter's presentation in Section 7.2 for more information on Keynsham Civic Centre which was built to a tight budget but is on track to deliver its target of a DEC A two years after occupation.

2.2 Costs

National legislation, such as building regulations and local Planning policies have steadily pushed sustainable construction requirements upwards over the past years. Complying with higher levels of energy efficiency, assessing the feasibility of on-site low or zero carbon energy sources, and fulfilling BREEAM criteria (Building Research Establishment Environmental Assessment Method- often mandated by Planning) has increasingly become the norm. Correspondingly the supply chain and industry knowledge has developed to meet this market demand. Prices for components and energy saving devices have fallen. Technologies that once were seen as highly priced products have reduced in costs. This is nowhere more noticeable than in the PV supply chain: globally PVs have seen dramatic drops in module prices since 2008.



Sustainable design and construction needn't cost more; in fact savings on systems can be made by providing a sustainable design that that prioritises natural ventilation and daylight, providing these savings by reducing the need for mechanical plant. Studies by BRE show that buildings can achieve very good and excellent environmental rating at very little additional cost. For example, a naturally ventilated office, a BREEAM Good rating can be achieved for a saving of between 0.3% and 0.4% of capital cost. A very good rating can be achieved for between a cost saving of 0.4% and an additional cost of 2% for a range of locations (BRE and Cyril Sweett, 2005).

Most importantly, sustainable design can make significant savings on the running costs over the life of a building. Therefore whole lifecycle costs should be considered, apart from simple payback, in the design process as a minor increase in capital cost may have potential to unlock major operational cost savings.

The falling build costs of sustainable building are reflected in the case studies presented in this report. For example, Architype has experience of providing Passivhaus certified projects at cost parity with a 'business as normal' approach:

In 2011 Oakmeadow and Bushbury Hill schools were delivered to certified Passivhaus standard within Wolverhampton City Council's budget for a standard building regulations standard school. This was achieved by keeping the form and detailing of the buildings simple, and offsetting items of extra cost (such as triple glazed windows), against savings (including reduced heating systems).

In 2014 designs for the new Archive and Records Centre for Herefordshire Council were costed to BREEAM Very Good and Passivhaus. The Passivhaus option proved to be 4.5% less in cost that the BREEAM, and was delivered within the estimated budget of £1,980 / sqm. This compares to a typical new archive building cost of £2,700 / sqm.

Gale & Snowden's has been delivering Passivhaus delivered within social housing budgets:

Since 2008 Gale & Snowden have been involved with the design and delivery of more than 200 Passivhaus dwellings for local Councils in the South West including the first multi-residential Passivhaus building completed in 2010. The first projects were delivered at a premium of 20% when compared to standard affordable housing projects. Additional costs were related to improvements to fabric performance (more insulation, triple glazed windows and doors), mechanical ventilation heat recovery and air tightness.

Since then additional costs for delivering Passivhaus could be significantly reduced and at the same time Building Regulation energy performance requirements were improved, bringing standard construction and Passivhaus closer together. Nowadays there is an improved supply chain of suitable products, and knowledge amongst designers and trades persons around the Passivhaus standard has improved.

Since 2014 we have been delivering Passivhaus social housing schemes at standard BCIS construction costs at £1,150/m2 GIA. Whilst elements like air tightness and MVHR will still come at a premium these additional costs are generally offset by a more rational building design and layout and savings from reduced mechanical plant like heating etc.

The case studies found in Section 8.0 provide a range of costs on completed projects. As with any building project, the costs reflect each project's unique site location, programme length, brief requirements, specification and contractual routes. Whilst they may provide a useful basis from which indicative cost ranges may be deduced, caution should be excised on extracting the cost figures without the project context.

2.3 Sustainability as a Value for Investors

"Health and well-being is rapidly emerging as an important area of opportunity for the real estate industry. Property companies and funds are experimenting with new strategies to improve internal operations, while creating new offerings to create competitive advantage and value for customers." Global Real Estate Sustainability Benchmark (GRESB)

GRESB is a global scheme that assesses the sustainability performance of real estate portfolios around the world; benchmarking each portfolio against competitors. It's used by property investors, e.g. Standard Life, Legal & General JLL, CBRE, Prudential etc.

A lot of investment companies demand scores in excess of 50% (achieving 'green stars' status) for all the funds they were investing in.

Scores are awarded as follows:

- A score < 50% for MP and IM - Green Starters
- A score ≥ 50% for MP, but < 50% for IM - Green Talk
- A score < 50% for MP, but ≥ 50% for IM - Green Walk
- A score ≥ 50% for MP and IM - Green Stars

The scores are taken from two sections:

- Management & Policy (MP) - assesses the sustainability and energy monitoring policies and procedures in place and is worth 30% of the overall GRESB Score.
- Implementation & Measurement (IM) - constitutes the actual energy and GHG performance of the fund, any initiatives implemented, and certifications obtained etc. and is worth 70% of the overall GRESB score.

To date GRESB has been mainly energy GHG emissions focussed but as of this year, 2016, they have launched their pilot Health and Well-being Module as a supplement for this year's Real Estate Assessment.

The Module has two areas of focus:

1. The promotion of health and well-being for employees
2. The provision of products and services that help promote health and well-being for tenants and other customers

The aim of the module is to address the growing interest in health and well-being in buildings and the lack of practical tools available to investors, property companies and fund managers to assess, objectively score and benchmark buildings that take employee health and wellbeing into account. Whilst this year's participation in the module (it is voluntary this year) will not impact on the entity's GRESB score, responses will be validated as part of the overall process for GRESB Real Estate Assessment. It is anticipated that the module will be enforced next year.

Further information can be found at: https://www.gresb.com/

In 2014, GRESB benchmarked real estate companies with assets worth USD $2.1 trillion, covering 56,000 buildings. For comparison, the FTSE EPRA/NAREIT Global Index has a combined market capitalization of approximately USD $2 trillion.

Elsewhere, Bob O'Brien, Deloitte's Global and US Real Estate Industry Leader, is of the opinion that investors now consider sustainability as a significant value added to real estate transactions: "Further, there is an increase in awareness and implementation of sustainability initiatives aimed at energy, water, and waste efficiency as indicated by a growth in green building certifications. The combined demands of occupiers, investors, and regulators are such that tangible benefits can be derived from embedding sustainability into the full investment process. Going forward, adoption, measurement, and reporting of sustainability initiatives will be a business imperative, given the broader benefits on rental growth, yield premiums, total occupancy costs, asset values, and marketability.[1]"

Another report assessing the link between sustainability and performance of Real Estate Investment Trusts (REITs) was published in July 2015 by the Carbon War Rooms.

Sustainability performance was measured by GRESB and financial performance by operational returns on assets (ROA) and returns on equity (ROE) and stock market performance (stock market return and alphas and betas- the risk ratios investors use as a way to calculate return on investment).

The dataset provided by GRESB, covering the 2011–2014 time periods, included 442 detailed sustainability ratings for global REITs, a subset generated from responses to GRESB of over 1,000 listed property companies and private equity real estate companies.

The study provides additional evidence that investing in sustainability makes good business sense. REITs with higher GRESB scores have higher returns on equity, higher returns on assets, and stronger risk-adjusted stock performance. This outperformance is largely driven by performance in the Implementation & Measurement dimensions.

A full copy of the report is downloadable here:
http://carbonwarroom.com/sites/default/files/reports/Green_REITs_FINAL.pdf

Further reading
Business Case for Building Green- World Green Building Council
http://www.worldgbc.org/files/1513/6608/0674/Business_Case_For_Green_Building_Report_WEB_2013-04-11.pdf

Sustainable Investment in Real Estate:
https://www.perenews.com/SustainableInvestment/

[1] 2015 Commercial Real Estate Outlook, Interview.
http://www2.deloitte.com/us/en/pages/financial-services/articles/2015-commercial-real-estate-outlook-qa.html (accessed 15/06/2016)

3.0 MANAGING THE PROCESS TO ACHIEVE SUSTAINABILITY OUTCOMES

3.1 Introduction

Sustainability certification is becoming increasingly widespread, for example, many local authorities require non domestic development to achieve BREEAM certification. There is increasing interest in the Passivhaus standard and it becoming more well-known and sought after in the UK, following a surge in uptake in other European countries. The pros and cons of formal certification are considered below, along with other frameworks (namely the Max Fordham Sustainability Matrix and Soft Landings process), and contractual routes that have previously been used by the Council to manage the construction process to achieve sustainability outcomes. These can be used either in conjunction with formal certification or as an alternative to it. Options and recommendations for sustainability standards and methodologies are set out later in the report.

3.2 Certification - Pros and Cons

An environmental rating assessment, such as BREEAM or Passivhaus, can be a concise way to demonstrate sustainability credentials. Certification is a form of quality assurance of sustainable design and is independently assessed. BREEAM is the most commonly used construction industry environmental assessment tool in the UK. It is usually well understood by planners, funders and the practitioners on the project.

However, BREEAM requires very specific criteria to be met, which leaves little room for flexibility in design or approach. In addition, the BREEAM scoring methodology & weighting may mean that some design measures are prioritized over others, despite not delivering real environmental returns for the actual project. It is also worth noting that the documentation required to provide evidence for an assessment scheme such as BREEAM, can be laborious to produce and requires significant time input from all design team members as well as the client, which may be better spent elsewhere.

Other certification systems, such as Passivhaus are more often than not more focused on sections of sustainability- i.e. Passivhaus is focused around energy & comfort, it does not assess ecology or community engagement. Other schemes such as Sentinel Haus are focused on off-gassing and indoor air quality.It is important to consider the project's sustainability criteria, as key issues of specific concern may not be measured within a chosen certification scheme. Selecting the right assessment tool is of critical importance in the brief development phase on a project to enable the assessment tool to drive sustainability standards and outcomes in the right direction. That said an environmental rating assessment may be the most appropriate and concise way to demonstrate sustainability credentials for a project. It has the value of being communicable to stakeholders and the market, and being independently verifiable. For this reason, certification comprises 11% of the score on the GRESB assessment of the sustainability of an asset[2].

[2] https://www.gresb.com/realestate2015/survey

3.3 Max Fordham Sustainability Matrix

Max Fordham Sustainability Matrix
Max Fordham LLP have developed the Sustainability Matrix over 10 years ago in collaboration with Feilden Clegg Bradley Studios, as a framework to present the range of sustainability options available for a project, covering not only the more familiar parameters of energy and water but also wider sustainability parameters such as procurement, indoor health, management, equity, education and community. It was utilised with the Keynsham Civic Centre project to set the project's sustainability priorities. Max Fordham led a number of meetings during the design process to agree the project's sustainability targets using their Sustainability Matrix. Max Fordham also led the Softlandings approach.

In any given project, many design agendas will be in competition with each other, so it is important to know where to focus effort to meet the project's sustainability aspirations. Once agreed, targets can be easily documented in the tool.

For each sustainability criteria (recorded vertically) four standards are set- from minimum through best practice to pioneering (recorded horizontally). Minimum standard is based on the current legislative regulations and each column to the right shows progressively more sustainable options. When a target is agreed for each criterion, a coloured profile can be mapped out, showing the unique aspirations of the project: thus providing a simple diagrammatic overview of the areas where a project is going beyond the regulatory norm.

There is no point scoring system and it is not necessary to understand the technical detail to get a feel for whether the target is a standard approach or very challenging. Generally if the target is to the left then it is normal practice, and if the target is towards the right then it is much more sustainable and usually more difficult.

Unlike a certification system there would be no need to meet any specific target that is not felt applicable to a project. BREEAM technical requirements can be inserted (typically best practice and beyond) where these are relevant, to demonstrate alignment with the standard. Unlike BREEAM no evidence collection is necessary to certify that a target has been achieved. The process relies on the commitment of client and design team to work towards agreed aims.

The Sustainability Matrix's strength lies in its ability to capture the breadth of sustainability issues considered, whilst giving succinct picture of the particular goals and focus of a project.

It has been used in public consultations; stakeholder meetings; discussions with funding bodies as well as with Planning Officers.

We have had positive feedback from funding organisations who have accepted the methodology as evidence of a sustainable agenda. In addition two of our current projects in Brighton and Bristol have had the Sustainability Matrix accepted by Planning in lieu of BREEAM.

3.4 Soft Landings Framework

Soft Landings is a framework that seeks to address the performance gap between designed and actual energy performance. It was utilised with the Keynsham Civic Centre project, and is the first office project in the UK to target a DEC A using the Softlandings Framework.

The Soft Landings concept originated over ten years ago, with an industry vision to develop an approach to project procurement and handover that would deliver better building outcomes. It is an enhancement of the conventional design and construction process: a collaborative approach affecting all stages of the building process, from briefing, through design and construction, and continuing for a period after the building is occupied to ensure that the building operates to its full potential.

The Soft Landings approach requires a significant shift from the traditional mind-set: specific emphasis is put on incorporating the needs and experience of building managers and occupiers from project inception, as well as at the crucial handover process, so that the building's operation is thoroughly considered and tested. In addition, the design team remains involved (between 1 to 3 years) after the building is occupied to provide support, review and fine tune the systems to maximise comfort conditions and minimise running costs.

Why Soft Landings is needed
Modern buildings are often complex. The people who manage them may often be unprepared for the task, or unfamiliar with the particularities of an installed system. Frequently, commissioning is squeezed at the end of projects. The reality is that fine tuning and seasonal commissioning are required once a building is occupied to ensure that the systems perform optimally. Furthermore, there is little contractual requirement for designers and contractors to stay beyond practical completion, and whilst customer support after handover is planned, it is rarely delivered. This can lead to incomprehension among end-users, frustration and the on-set of a negative blame culture. When chronic underperformance sets in, not only can the causes be difficult to identify, they may be difficult to rein in and thus opportunities and solutions can be missed.

Soft Landings aims to plan for and avoid these pitfalls by focussing on delivering buildings that really work for their owners and occupiers: buildings that are comfortable and straightforward to use, and with systems optimised to minimise running and maintenance costs.

Approaches to Soft Landings
In the UK there are two official approaches to Soft Landings: one following the BSRIA Framework, the other following the Government Soft Landings policy. Common to both approaches is the intention is that a longer, collaborative process beyond construction completion will ensure that

handover becomes a smooth process, operators are trained, and optimum performance outcomes become a focus of the whole team.

The BSRIA Soft Landings Framework - (First published 2009 updated 2014)
The BSRIA Framework aims to encourage a cultural shift towards increased collaboration and awareness of project outcomes through the use of stakeholder workshops and design reviews. It is a flexible and adaptable framework set around 12 core principles, which are interpreted to suit project specifics, taking project uniqueness and individuality into account. Project targets and metrics are set by the project team.

The Government Soft Landings policy
The Government Soft Landings policy was driven by the Government Construction Board and evolved during the period 2011/12. In Sept 2012 the Cabinet Office formally announced that by 2016 all centrally funded projects should be delivered in accordance with the Government Soft Landings policy. (The policy does not explicitly recommend the adoption of the BSRIA Soft Landings Framework, rather it references it- allowing the Government to manage their own interpretation of Soft Landings.)

The aims of Government Soft Landings are about adopting a mind-set and a process to align design and construction with operational asset management and purpose. Government Soft Landings is designed to cater for the procurement needs of central government departments, and is a requirement for all new project and major refurbishment projects. The adoption of the policy is part of the Government's effort to help reduce total project costs through the lifetime of the asset.

Differences
Comparing the two approaches, the Government Soft Landings scheme is more prescriptive about monitoring against set performance objectives and is aligned to BIM coordination, whereas the BSRIA Framework does not inherently require or reference BIM.

Whilst project outcomes should be reviewed and agreed at the beginning of a project under both systems, Government Soft Landings identifies a range of economic, social and environmental metrics that must be assessed. Under the BSRIA Framework, project teams have the freedom to set their own range of assessment measures.

The required outcomes for Government Soft Landings (measured by post occupancy evaluation) are as follows:

1. **Functionality and effectiveness:** Buildings designed to meet the needs of government department occupiers; comfortable, usable, manageable and maintainable environments conducive to occupant productivity.
2. **Environment:** Meet government department performance targets for energy use, carbon dioxide emissions, water usage and waste reduction.
3. **Cost:** Meet government department targets for capital and operational cost.

The required processes (measured by key performance indicators) are as follows:

4. **Facilities management:** A clear, cost efficient strategy for managing the operations of the building.
5. **Commissioning, training and handover:** Projects delivered, handed over and supported to meet the needs of the end users.

Both approaches seek to stress the importance of a period of extended aftercare; however the motives for engagement and evaluation are slightly different. The BSRIA Framework sees the evaluation as a component of extended aftercare by the professional team, whereas Government Soft Landings views the evaluation as a crucial means for clients to check that performance targets have been met.

The Government Soft Landings approach emphasizes that it gives clients additional assurance of being able to address operational needs and running costs, adding to the efficiency of their business, as well as resulting in buildings that are cheaper to construct and operate because they do not require changes after handover since user and operator needs have been assessed throughout the design process. The focus on quantitative metrics and costs within the Government Soft Landings approach is consistent with the objective of the policy. It was adopted as part of the drive to procure Government Departments' projects at 20% lower costs.

Max Fordham believes that the Soft Landings approach should deliver lower *whole*-life costs but believes this will frequently come about with a slightly increased initial investment.

3.5 A Selection of Energy Modelling Software to Address Overheating & the Performance Gap

The problem of the Performance Gap
The Performance Gap is a term which describes the disparity that occurs between the predicted energy use at the design stage of a building an the actual energy use of those building once occupied and in operation.Over the past years, the awareness and concern of the dangers and problems of the Performance Gap have become more wide spread throughout the construction industry and government. The Performance Gap could undermine a building's ability to meet legislative carbon reductions, undermine the building industry's vital role to contribute to the national carbon reduction plan as set out in the Climate Change Act 2008, as well as presenting a reputational risk to the industry and damage consumer confidence if energy bills are higher than anticipated.

A note Modelling
To assess the anticipated energy performance of a proposed design, a form of building energy performance simulation tool needs to be used. These software models use different methods to predict likely energy performance. Used as part of the design process, software models help designers predict annual energy consumption and size and select building equipment, as well as achieving improved energy performance standards. Software model predictions are often required as compliance tools. It is important to choose the right software tool depending on the intended application. It is important to get as accurate and realistic a picture of energy use as possible, to mitigate overheating and to achieve the required higher levels of efficiency and efficacy, as well as to address the performance gap.

IES (Integrated Environmental Solutions) and PHPP (Passive House Planning Package) are leading energy performance simulation software. Below is a descriptor of each, their respective merits, disadvantages and comparative accuracy. N.B. Both tools may be needed since they have different roles to fulfil.

IES - Integrated Environmental Solutions
IES is a dynamic model using hourly climate data, it requires a great amount of detail to generate reliable results, and varies dramatically depending on the user inputs. IES models areas like over heating and ventilation, but its standard occupancy profiles are limited/inputs vary dramatically depending on the user inputs- i.e. the IES results are only as good as the inputs and assumptions made.

However, IES may be required by planning: Part L2A requires SBEM modelling to be run, to demonstrate compliance with CO2 emissions targets. Although a proprietary 'ISBEM' tool is available, Max Fordham only use IES as the tool for CO2 compliance for Part L2A.

Furthermore, IES may be the preferred method to demonstrate summer comfort as PHPP isn't known to be a very robust way of assessing summer comfort. A well modelled IES or Wufi Plus model is able to accurately predict room by room overheating better than PHPP. IES has its uses for more detailed analysis of room by room overheating.

Where Gale and Snowden have used IES in parallel with the PHPP, the energy demand in the PHPP calculations were regularly double than what the IES modelling showed. When they then monitored the completed buildings the PHPP matched the real energy use much closer.

Therefore, if IES is used it is important to interrogate the data inputs in the model and how summer ventilation and occupancy profiles are being modelled, as these areas are where the discrepancies can lie.

PHPP - Passive House Planning Package
PHPP is a precise steady state model that uses monthly averaged climate data developed and amended by PHI. Only PHPP can be used to design, optimise and certify to Passivhaus, and guarantee energy targets and test overall building overheating.

PHPP gives you a whole volume assessment for overheating on conservative logarithms that have recently been updated in the latest version of PHPP. It doesn't give you specific room by room information, which a dynamic model such as WUFI Plus or IES does.

PHPP takes more cautious and pessimistic assumptions than IES, based on the fact that reality is never as goods as theory, in order to ensure that real performance will match predicted (which it is proven to do so). PHPP is a very good design tool because it gives instant feedback to any change in design or fabric, whereas IES takes more to input and longer to render each result. A key strength of the PHPP in this regard is that it allows for very accurate estimations with very limited data input. This makes it relatively quick and easy to apply and allows for thermal modelling at the earliest design stages (early RIBA stage 2) when design info is limited but key decisions need to be made that will influence the performance of a scheme.

IES doesn't model the building fabric as exactly as PHPP (i.e. thermal bridges for example), or the services in relation to user control over outputs (length of pipe work, depth of insulation etc.), but it does cover them to a degree.

3.6 Future Climate Resilience

Why is it's important
Climate change will affect aspects of the built environment including external building fabric, structural integrity, service infrastructure (e.g. drainage, water, waste, energy, transport and telecommunications). Climate change adaptation strategies seek to mitigate these adverse impacts through design and through the way in which people use indoor and outdoor space.

Future climate: Temperature
Summers are likely to be hotter. By 2050 the average summer day is likely to be 2.7C warmer and very hot days 6.5 C warmer than the baseline average. By the 2080 the average day is likely to be 3.9 C hotter and the hottest day of the year could be 10 C than currently. Winters will be warmer, with the average, mid-century winter's day being 2.2°C warmer and a very warm winter day 3.5°C above the baseline. Very cold winters will still occur, but will occur less frequently.

Future climate: water/ moisture and precipitation
Summers are likely to be drier. By the middle of the century, the average summer is projected to be 19 % drier and the driest summer 39% drier than the baseline average. By the end of century average summers could be 23% drier than today.

Winters are likely to be wetter. By the middle of the century, the average winter is projected to be 15% wetter and the wettest winter 33% wetter than the baseline average.

Overall the total annual rainfall will not change significantly but the distribution of the rainfall may change to wetter winters and drier summers. This would increase the intensity of rainfall associated with extreme events in the winter and water scarcity in summer.

Overheating
Overheating of the domestic and commercial units on the site is a significant hazard in a future climate. In order to achieve tolerable or acceptable internal conditions the solar and internal gains will need to be reduced significantly. Where these measures are not possible cooling technologies may need to be considered to achieve acceptable levels of comfort.

If internal temperatures exceed 28°C the productivity of the occupants of the internal units will decrease significantly. At temperatures of 35°C work will only be possible for limited periods of time and beyond 38°C productive work within the buildings will be extremely unproductive. At these temperatures the commercial units will not be fit-for-use and are likely to be redundant. If cooling technologies are specified then the units will be useable but this cost may not be viable if future energy costs are as high as projected. If future levels of solar radiation and associated air temperatures are not considered in the design of the site then the buildings are likely become uninhabitable by 2080 or even 2030. The risk of not considering the impact of increased solar radiation in future climate is unacceptably high as it could threaten the viability of the units long before the end of their design life-time.

Climate ready design & adaptability
Building design must ensure buildings remain fit for purpose throughout their lifespan. The strategy for this is as follows:

1) Evaluate the potential impact of these risks on the building.
Perform a full risk assessment of future climate impacts, including overheating and more extreme weather events such as heavy rain, storms and droughts must also be considered.

2) Determine the tolerable risk threshold.
For example: the design should ensure that the internal temperature of all the units does not exceed 28°C for more than 1% of the occupied hours and should not exceed 32°C in the future climate medium emission scenarios. Rainwater goods must be designed to cope with very heavy rainfall and subsidence issues in the case of drought and ground saturation should be considered.

3) Design the building to avoid these thresholds
The method for doing this with regards to overheating is set out in the table in Section 4.0.

3.7 Contractual routes

Contractual routes to secure set sustainability standards may differ from project to project.

Max Fordham developed the concept and the documentation of performance contracting, on Keynsham Civic Centre. The DEC A rating was written into the contract. *But how do you transfer responsibility for actually delivering this to the contractor?* This is the essence of Energy Performance Contracts – but there are pitfalls for the unwary. If you try and pass on <u>all</u> the risk, there is a danger that other parties will focus more on minimising commercial risk rather than optimising the outcome for the building. At Keynsham, Max Fordham explicitly made the contractor responsible only for the things they could control. And rather than mandate the performance outcome, Max Fordham mandated the process to evaluate the performance.

As the amount of energy a building consumes is heavily dependent on how it is used, there is a lot outside the control of the contractor or developer. Max Fordham set an Energy Budget for the building with clear division of responsibility. For each energy end-use (heating, lighting, etc.) Max Fordham explicitly set out the assumptions that the energy calculations were based on and identified those within the control of the contractor and those beyond. This is an innovative approach which aims to create an open and collaborative environment that allows all parties to work towards the best outcome, while maintaining some accountability. It acknowledges shared responsibility.

Max Fordham's tender documents outlined what was expected of the contractor during the aftercare period. They set out a process to optimise performance that includes monitoring energy use on a monthly basis against the Energy Budget and establishing the reason for any significant discrepancy. Regular aftercare meetings are being held, with the client's Facilities Management team and building users, to review the findings and agree what corrective actions are needed. Some of these actions will be defects, some will be fine-tuning and others will be operational issues for the FM team to take on board. The time needed for this 'fine-tuning' was accounted for in the appointments of the various sub-contractors. In some cases, the client team may decide that their current needs differ from what was in the brief. If this is the case, they will need to understand the consequences and accept the impact this may have on the energy target.

Copies of the contract documents (Softlandings ITT Questions; Keynsham Town Hall Softlandings Contract Preliminaries; Keynsham Town Hall Employer's Requirements Prelims) can be found in the Section 7.0.

Gale & Snowden's comments on contractual routes to achieve Passivhaus:
Contractual arrangements: key to the successful implementation of Passivhaus is the early adoption of this standard. Designs need to be developed from the outset following the PH methodology to maximize every potential and to ensure economic viability. If the standard is adopted too late in the process often key decisions regarding orientation, form but also construction and airtightness strategy are too far progressed to allow for an optimum solution and experience shows this will increase costs and put unnecessary challenges on the site team and contractor. With regards to building contracts we advise our clients to go for Passsivhaus certification and make it a contractual requirement. Both the Passivhaus certifier and the final air pressure test at practical completion remain on the client's side to ensure they are independent. A key challenge on site for delivering PH in the UK remains air tightness and we always include the role of an airtightness champion in our specification. This role typically sits on the contractor's side and is a senior member of their organization. Their role is to oversee the implementation of the airtightness strategy, coordination of the various trades involved, overseeing pre completion air tests and ensuring the stringent Passivhaus targets are met. It needs to be a sufficiently senior person within the organization so he can put the project on hold if targets are not met. We normally include a detailed description of the role and responsibilities in our air tightness specification. Over the last years we have also experimented with different forms of contractor involvement including traditional procurement, DB, single and two stage tenders. In the end we believe there is no single preferred route and it is all about individuals and the right attitude. We have been involved with the design of almost 200 Passivhaus dwellings over the past 8 years. On almost every project the contractor we worked with had no Passivhaus experience. In the end they all achieved it on time or with minor delays and within budget.

Architype's comments on contractual routes to achieve Passivhaus standard:
We have not used any particular contractual arrangements - most of early Passivhaus projects have been designed to Passivhaus in the simplest possible way, to make it achievable for contractors to deliver it. This was been backed by a collaborative and supportive approach, with support, advice and training given to assist contractors and their subcontractors. In some cases this has been done using a two stage process, in order to bring the contractors into the process early and involve them in the detailed design.

In recent projects achieving Passivhaus has been given as the contractual standard that has to be achieved, and contractors are beginning to see that as just one of several standards that they need to comply with.

4.0 OPTIONS FOR STANDARDS, METHODS AND IMPLENTATION OPTIONS

The subsequent table sets out options, methods and recommendations to be considered during the contracting process for new developments. For energy standards, the focus is on standards and methods which aim to close the performance gap; this is a key requirement of the Policy for Health & Sustainability in the Council's New Build Projects.

B&NES SUSTAINABILITY STANDARDS TABLE

	Standard or Methodology	Description	Pros and Cons	Method	3rd Party Quality Assurance	Further Reading/ Case studies
ENERGY Standards or methods that can close the energy performance gap	**Passivhaus Classic**	Rigorous design methodology and assessment method for all building types. The following requirements need to be met: Space heating <15kWh/m2/yr OR Heating Load <10W/m2 Cooling Demand <15kWh/m2/yr OR Cooling Load <10W/m2 (likely to be relevant in the UK in coming years) Primary Energy <120kWh/m2/yr Overheating < 10% of hrs >25deg C Air tightness <0.6 ach@50PA	**Pro** Robust design methodology and quality assurance process with a proven track record of delivering truly energy efficient buildings with outstanding thermal comfort and air quality, closing the performance gap. - Scalable, works on any size /type building - Ensures excellent indoor air quality (IAQ) - Clear targets and methods of measuring success - Design & construction verified **Con** It is not a carbon assessment method and focusses on energy, efficiency, comfort, air quality and hygiene Does not asses or address wider sustainability issues	Whole building energy and comfort model needs to be verified using the Passivhaus Planning Package (PHPP) methodology. It is recommended that an experienced specialist designer is employed to assist with this process. Also rigorous QA / documentation process must be implemented for design and construction for Building Certification	The Passivhaus Institut offers an optional quality assurance process via their network of Passivhaus Building Certifiers. Following completion and after successfully passing this rigorous assurance process the project can be certified as a 'Quality approved Passivhaus'. Meeting this standard can be made a requirement within the building contract The cost of an assessment depends on the individual project. For a blocks of flats or row of terraces this would typically be in the region of £2,500+VAT	Passivhaus standards: http://www.passiv.de/en/03_certification/02_certification_buildings/08_energy_standards/08_energy_standards.html Examples: http://passivehouse-database.org/index.php?lang=en For the UK only: http://www.passivhaustrust.org.uk/projects/
	Passivhaus Institut Low Energy Building Standard	Same rigorous design methodology and quality assurance method as Passivhaus Classic, but with a relaxed space heating energy target of 30 kWh/m2/yr Other Passivhaus standards available include: - 'Passivhaus Plus' (includes renewable energy generation) - 'Passivhaus Premium' (includes renewable energy generation beyond building need) - 'EnerPHit Classic / Plus / Premium' for retrofits - Full criteria http://passiv.de/downloads/03_building_criteria_en.pdf	**Pro** Robust design methodology and quality assurance process with a proven track record of delivering truly energy efficient buildings with outstanding thermal comfort and air quality **Con** It is not a carbon assessment method and focusses on energy, efficiency, comfort, air quality and hygiene Does not asses or address wider sustainability issues	Energy demand needs to be verified using the PHPP methodology. It is recommended that an experienced specialist designer is employed to assist with this process.	The Passivhaus Institut offers a similar quality assurance process via their network of Passivhaus Building Certifiers. Following completion and after successfully passing this rigorous assurance process the project can be certified as a 'Quality approved Passivhaus' Meeting this standard can be made a requirement within the building contract. The cost of an assessment depends on the individual project. For a blocks of flats or row of terraces this would typically be in the region of £2,500+VAT	http://www.passipedia.org/_media/picopen/phi_building_criteria_draft.pdf
	AECB Silver (using the Passivhaus process)	Self-certification scheme i.e. the designer signs a form that they believe they have met the standard. Uses Passivhaus design methodology and modelling tool but allows for an increased energy target. No independent third party quality assurance. Self certification. The following requirements need to be met: Space heating <40kWh/m2/yr Primary Energy <120kWh/m2/yr Overheating < 10% of hrs >25deg C Air tightness <1.5 ach@50PA with MVHR (<3 ach@50 Pa if MEV)	**Pro** Design methodology based on PHPP. **Con** It is not a carbon assessment method and focusses on energy, efficiency, comfort, air quality and hygiene Self certification Not well known Not as robust as other certification routes	Whole building energy and comfort model uses PHPP	No. Self certification by designer The cost of an assessment is £60 for AECB members and £250 for non-members	http://www.aecb.net/aecbs-silver-standard/
	Energy Budget and Energy Performance Contracting	Performance contracting: specify operational energy target e.g. Display Energy Certificate (DEC) A in contract. DECs provide an energy rating of the building from A to G, where A is very efficient and G is the least efficient and are based on the actual amount of metered energy used by the building over the last 12 months within the validity period of the DEC. The energy budget is applicable to the contractor's part of the design, such that the detailed design is completed within the energy budget set. This ensures energy performance remains a key criteria during plant selection, not just cost! The contractor can still be required to monitor the energy in use against the energy budget and explain any discrepancies. They can be responsible for the optimising the performance of the fixed services, whilst acknowledging the impact the occupants have on this.	**Pro** Closes the Performance Gap Energy Performance Contract should define exactly what the contractor is responsible for (i.e. only what is in their control) **Cons** If all the risk is passed on, there is a danger that other parties will focus more on minimising commercial risk rather than optimising the outcome for the building	The DEC target must be written in to contract. For effective implementation Energy Budgets for the building with clear division of responsibility should be set Requires engagement from all parties, including client for the areas within their control and responsibility Tender documents should what is expected of the contractor in the aftercare period. Setting out a process to optimise performance that includes monitoring energy use on a monthly basis against the Energy Budget and establishing the reason for any significant discrepancy	National standard and calculation methodology All public buildings with floor area greater than 250sqm and which is frequently visited by the public must display a valid DEC certificate prominently at all times Other, non-public buildings, may follow the same methodology on a voluntary basis The calculations are standard allowing benchmarking across similar buildings of a particular type	Keynsham Civic Centre, BANES Council Offices HQ NABERS- National Australian Built Environment Rating System- a UK version of this is being investigated https://nabers.gov.au/public/webpages/home.aspx
	Soft Landings Framework	Soft Landings is a framework that seeks to address the performance gap between designed and actual energy performance. It is a conceptual framework that can be overlaid over the existing project processes. Collaborative working is central to the methodology, the focus is on operational outcomes. Through performance benchmarking, reality checking, graduated handover, fine tuning Aftercare and post occupancy evaluation better performing buildings can be delivered.	**Pro** Closes the Performance Gap. Early engagement of the design team with occupiers and facility managers ensures the brief formulation and development is in alignment with desired operational outcomes **Con** Relies on collaboration and client engagement	BSRIA framework is industry standard Government Soft Landings (GSL) is now requirement on government funded projects as part of the BIM requirements	No. Relies on collaboration of project team	The following BSRIA guides are free downloads and can be found at www.softlandings.org.uk BG 54/2014 Soft Landings Framework BG 38/2014 Soft Landings Core Principles The Government Soft Landings policy can be found at: www.bimtaskgroup.org/gsl/

B&NES SUSTAINABILITY STANDARDS TABLE

BANES SUSTAINABILITY STANDARDS TABLE

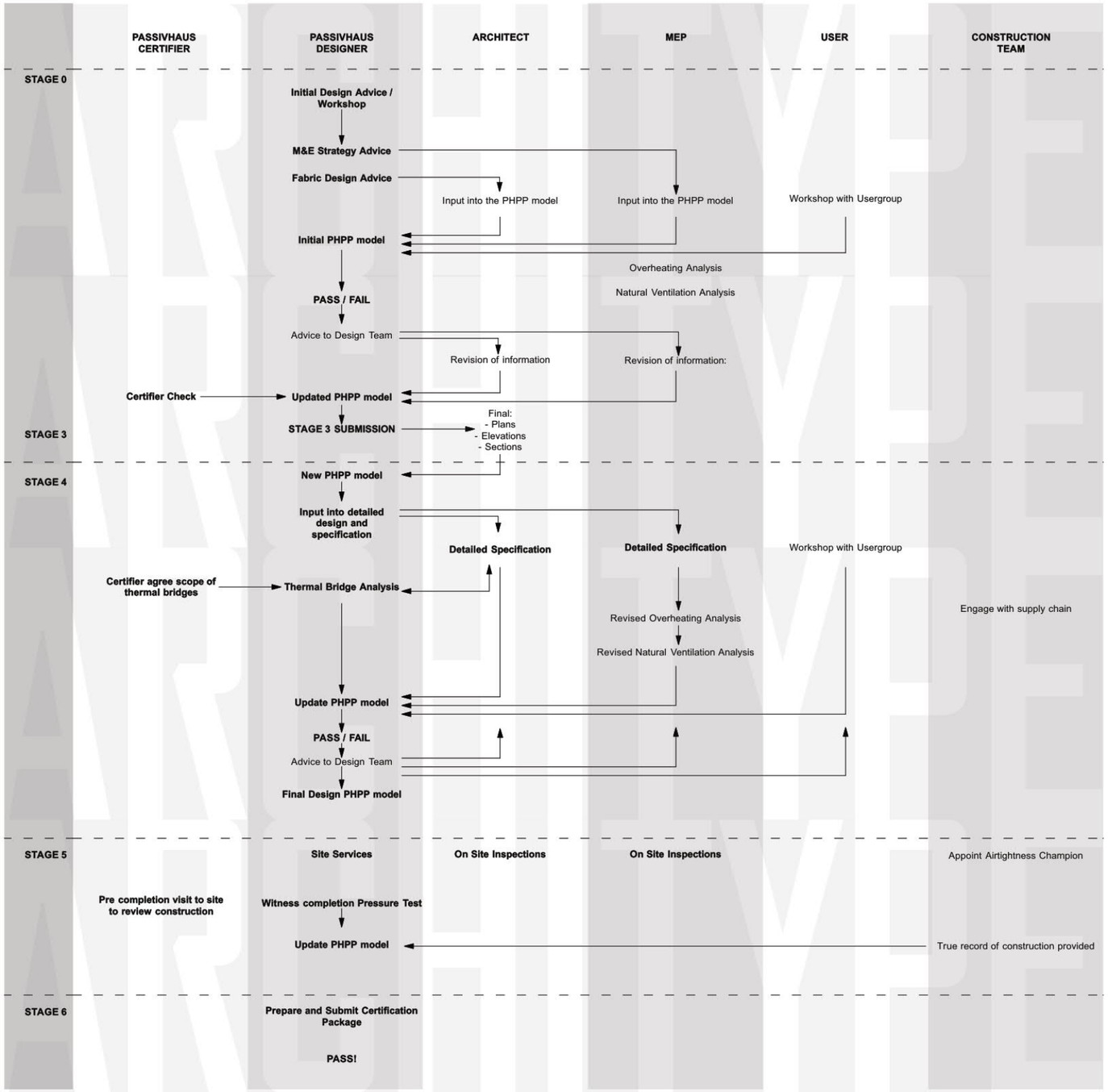
	Standard or Methodology	Description	Pros and Cons	Method	3rd Party Quality Assurance	Further Reading/ Case studies
HEALTH	**WELL Building Standard**	The WELL Building Standard®, run by the WELL Building Institute, is an evidence-based system for measuring, certifying and monitoring the performance of building features that impact health and well-being. Certification Criteria: Air, water, nourishment, light, fitness, comfort and mind	**Pros** It is a standardised way to demonstrate commitment to the wellbeing objective. It is gaining momentum, particularly in London, as the Wellbeing agenda becomes increasingly prominent. It is fairly straightforward process to follow, as per BREEAM. **Con** The standard was developed in the US and not all elements had been adapted for the UK at time of writing. For example, Silver is basically met by meeting Building Regulations in the UK since UK standards are higher than the US. It is a very similar process to BREEAM in terms of a checklist of items to obtain points, rather than a bespoke solution reflecting the priorities of the project.	• Audit documents, on-site assessor visit, including at 50% occupation. • Annual submission of documents to make sure filters are being changed etc. • Re-accreditation every 3 years • Can meet silver, gold or Platinum (see graphic)	Several UK companies are offering WELL Building certification, in accordance with the WELL Building Institute methodology. Cost of certification: $13,750. £29,000 recently quoted for the entire certification process for a medium sized office project in B&NES.	Parent Organisation: Delos (US) Introduced 2015 http://www.wellcertified.com/sites/default/files/resources/WELL%20Certification%20Guidebook.pdf
	Building Biology	Addresses 13 key criteria for healthy buildings through a bespoke consultancy and assessment process.	**Pros** Is a flexible process where the priorities can be set for each project. It is measured by actual testing of, for example, air contaminants. **Con** It is quite an intensive process throughout the building programme	• Iterative process whereby qualified advisor works with the team to determine priorities and integrate throughout. Vital that the requirements are carried out by contractor	• Independent advisor creates a strategy at the design stage • Certified with the Building Biology Institute once testing has been carried out at completion if certain (quite exacting) criteria are met.	Parent Organisation: International Institute for Building Biology & Ecology (Germany) http://www.ecodesign.co.uk/approach/healthy-buildings/

		Issue	Description	Reasons for setting standard	Method	3rd Party Quality Assurance	Further Reading/ Case studies
HEALTH	Some Comfort parameters issues	**Daylight**	Daylight factor design to be delivered in accordance with: BS 8206-2 2008 Code of Practice for daylighting CIBSE SLL (Society of Light and Lighting) Daylighting and window design LG (Lighting Guide)10 1999 CIBSE Lighting Guide –Recommended Daylight factors: Offices/Schools: Average daylight factor 5%; minimum daylight factor 2% Residential: Kitchens 2%; Living rooms/dining 1.5%	Beyond the energy savings on artificial lighting, natural light is as much a nutrient as food and water. Benefits include: - daylit environments increase occupant/user satisfaction, mood, productivity and comfort - reduction in energy demand - daylight provides the mental and visual stimulation necessary to regulate human circadian rhythms ('body clock') - daylight controls the production of important hormones and vitamins, protecting from common diseases, including diabetes, osteoporosis, osteoarthritis, hypertension, cardiovascular disease, metabolic syndrome, depression, MS, and cancers	Daylight factors are to be verified as per the relevant standards. It is recommended that compliance is to be demonstrated by the design team/contractor at key gateways and prior to client's sign off at RIBA stages 2, 3 and 4.	It is recommended to appoint a technical advisor to provide an independent third party assessment to check compliance. This can also be imbedded into a building contract .	BRE: Daylight and shading: A collection of BRE expert guidance on designing for daylight and sunlight, and shading of buildings (AP 304)
		Comfort/Overheating	Overheating: To be based on thermal comfort methodologies found in the following British Standards: BS EN ISO 7730: Ergonomics of the thermal environment BS EN 15251: Indoor environmental input parameters The modelled building should comply with the adaptive thermal comfort criteria as set out in CIBSE TM52 (published 2013). In layman's terms these can be described in the following way: 1. **Too hot too often**, this is a % of hours over threshold temperature, but instead of being a fixed value the threshold temperature varies. 2. **A bad day is too bad**, this is a % of hours over a lower threshold in a day. 3. **Far too hot ever**, this is about the peak temperature ever being 4K above the threshold temperature.	Overheating affects productivity in an office environment and can affect the health of residents. Vulnerable inhabitants like elderly person and children are particularly at risk. Due to climate change extreme weather events and heat waves have become more frequent and issues of overheating in existing buildings have widely been documented.	Compliance is to be verified using dynamic simulations in accordance with good practice. It is recommended that compliance is to be demonstrated by the design team/contractor at key gateways and prior to client's sign off at RIBA stages 2, 3 and 4. Requirement and independent third party assessment can be imbedded in building contract.	It is recommended to appoint a technical advisor to provide an independent third party assessment to check compliance. This can also be imbedded into a building contract.	http://www.zerocarbonhub.org/sites/default/files/resources/reports/Understanding_Overheating-Where_to_Start_NF44.pdf
		Air quality	Specify measurable air quality standards based on scientific evidence that also cater for the most vulnerable of our society e.g. SBM 2015 The following requirements are recommended for offices, schools and residential developments: CO2 <800ppm on average during occupied hours RH 40-60% VOC <100 µg/m2 Formaldehyde <20 µg/m2 Pesticides < 5 ng/m3 Fire retardants chlorinated <0.5mg/kg dust halogen free <5mg/kg dust Plasticisers <100mg/kg dust Mould/bacteria/Particles/fibres should be below the common, external, uncontaminated levels. Yeast should not be detectable	On average we spend 90% of our time indoors where we exposed to chemicals off gasing from modern building products. Most VOCs are carcinogenic, mutagenic and reprotoxic and can cause chronic diseases like asthma. Especially vulnerable members of society are affected like children and elderly. The UK today has the highest asthma rate amongst children in the world.	Compliance should be tested at completion of the finished building and prior to handover. Standards like the SBM 2015 set out measurable targets for a healthy, risk free indoor environment and define testing criteria to allow for scientifically proven, reproducible results. These targets can also be specified and imbedded into a contract.	Optional a technical advisor could be appointed to act as independent third party assessor, to review design strategies advise the client on potential short falls and carry out the completion testing.	http://www.baubiologie.de/site/wp-content/uploads/richtwerte-2015-englisch.pdf

B&NES SUSTAINABILITY STANDARDS TABLE

	Standard or Methodology	Description	Pros and Cons	Method	3rd Party Quality Assurance	Further Reading/ Case studies
BROAD SPECTRUM SUSTAINABILITY	**BREEAM**	BREEAM is the world's leading sustainability assessment method for masterplanning projects, infrastructure and buildings under various different schemes. Various schemes address a number of lifecycle stages such as New Construction, Refurbishment and In-Use. Globally there are more than 548,400 BREEAM certified developments.	**Pro** Name recognition as a hallmark of sustainability in the UK Externally certified rigorous process- it has stood the test of time and is credible It is well understood in the industry Expected and often required for Planning **Con** Whilst BREEAM sets energy standards, the methodology in itself has been shown not necessarily to reduce the performance gap (cite BPE study) unless combined with Soft Landings or some of the other methods outlined in this study. It can be time and paperwork intensive Due to the point scoring and weighting methodology, it can potentially incentivise perverse choices Some issues are not dealt with successfully or at all in BREEAM such as: As built performance; Sustainable operation; Operational waste; Sustainable procurement and consumables; Education	Assessor receives and checks required evidence from design team and client. Their role is to manage the formal assessment process and apply for certification of that assessment on behalf of the client. In doing so they will confirm the appropriate scheme, apply the relevant scheme criteria and liaise with the client and relevant stakeholders to facilitate an assessment. Only BRE Global Ltd licensed assessors can offer, register, undertake and apply for certification of assessment. Certification is designed as a two stage process: with Design Certification submitted at RIBA Stage 4 and Post Construction Certification after building hand over.	Yes. Requires a qualified assessor and fees to BRE	http://www.breeam.com/
	Max Fordham Sustainability Matrix	Max Fordham developed our first Sustainability Matrix nearly 10 years ago as a communication tool to capture the wide range of sustainability issues on a project and illustrate its aspirations and targets. Since then we have used them on many diverse projects and have developed a set of standard Matrices covering museums, visitor centres as well as offices. On any given project, many design agendas will be in competition with each other, so it is important to know where to focus effort.	**Pro** The Sustainability Matrix approach is much broader than BREEAM, capturing social and economic sustainability impacts of a project. The approach is flexible and non-prescriptive; the targets are collectively agreed by the project team and are specific to each project so that effort and investment can be focused on client priority areas. As the project specific Matrix targets are owned by the design team, evidence does not need to be 'documented' separately. Progress, changes (and their consequences in terms of sustainability) are easy to map and trace. Process fees are lower than an independent certified rating system. **Con** The success of the approach is dependent on the engagement of the project team. It does not have the national recognition of BREEAM. It is not straightforward for it to be independently verified.	Collaborative workshop and ratification meetings. Stage reviews and checkpoints	No. Relies on collaboration of project team.	http://www.maxfordham.com/news/publications/sustainabilty-matrix-five-editions-combined
	Issue	**Description**	**Reasons for setting standard**	**Method**	**3rd Party Quality Assurance**	**Further Reading/ Case studies**
CLIMATE RESILIENCE	**Climate Ready**	The Building should be designed to be adaptable to meet predicted future weather without affecting the energy consumption of the building or compromising the healthy building principles. The design team to thermally model the building via dynamic analysis using industry recognised software (e.g. IES) and industry standard data and in addition the Prometheus Project (Exeter University) Weather files to 2030, 2050 and 2080 at 50 percentile high emissions scenario (a1fi) Contractor/consultants to demonstrate that there will be no increase in total energy demand (carbon emissions) under future climate scenarios.	The climate is changing. The building we create today will have to perform under very different conditions than the environment (today) they evolved in. Higher temperatures and more extreme weather events like draught, flooding , UV exposure and storm severity will affect internal comfort and longevity of these buildings. At the same time it can effect the energy demand where artificial cooling may become a requirement. Where e.g. a business case is build on low energy performance this canteen also affect the economic viability of a scheme.	Compliance is to be verified using dynamic simulations in accordance with good practice. Passive design strategies to be considered to improve thermal comfort includes improved ventilation (cross or stack ventilation) paired with thermal mass and solar control (shading, glazing specification etc.). Landscaping, green roofs and walls can be designed to moderate the micro climate and at the same time act as SUDs to prevent flooding etc. It is recommended that compliance is to be demonstrated by the design team/contractor at key gateways and prior to client's sign off at RIBA stages 2, 3 and 4. Requirement and independent third party assessment can be imbedded in building contract.	It is recommended to appoint a technical advisor to provide an independent third party assessment to check compliance. This can also be imbedded into a building contract.	https://connect.innovateuk.org/documents/3197389/3713440/Extra%20Care4Exeter%20D4FC%20Main%20Report.pdf https://connect.innovateuk.org/documents/3197389/11435499/Factsheet%2028_PassivOffices%204%20Devon%20at%20Devonshire%20Gate

5.0 IMPLEMENTING PASSIVHAUS THROUGH THE RIBA STAGES



6.0 TOP 10 MEASURES FOR SCHOOLS

Schools to whatever environmental standard have been traditionally designed as 'naturally ventilated', that is they rely either on occupants to open windows, or on some sort of automated 'natural' ventilation system.

Monitoring by Architype has found that this creates issues with internal comfort in winter, due to drafts caused by ventilation openings, or by CO_2 levels rising to levels well above statutory levels where ventilation is insufficiently manually controlled, or automatic systems are overridden by occupiers.

At the same time energy consumption in use is frequently found to above design levels, partly due to the heat lost through 'natural' ventilation, as well as wider construction, systems and controls issues.

One solution that can solve the gap in performance between design and occupation, for both internal environmental comfort and energy consumption is Passivhaus.

Monitoring over 12 months of 3 non-passivhaus schools (one 1970s and two recent BREEAM schools) and 3 passivhaus schools undertaken by Architype in partnership with Coventry University has found significant increase in environmental comfort as well as dramatic reductions in energy consumption.

The findings of the study are unequivocal. Both temperature and CO_2 levels were better in the Passivhaus buildings with MVHR in all seasons, than the non-Passivhaus buildings with natural ventilation.

In particular CO_2 levels are dramatically improved in the Passivhaus buildings with MVHR, especially in the more critical winter season.

Thermal energy consumption in the passivhaus schools was around 90% less, and overall energy 70% less, than CIBSE benchmarks.

The Passivhaus schools monitored were all delivered within standard budgets with no additional funding.

The key measures that have enabled improved environmental standards and lower energy running costs, with no additional capital cost are as follows:

1. Passivhaus was incorporated into the process from the earliest stage of design, i.e. not added part way through
2. PHPP (Passivhaus Planning Package) was used as a design tool to optimize design
3. Passivhaus expertise was engaged from the outset of the project, and included within the design team
4. There was a focus on creating a simple and elegant building form with an efficient ratio of external surface area to internal usable area
5. Care and attention was given to creating simple and robust details in which thermal bridging is eliminated, and the demanding airtightness targets can be easily achieved
6. The was a commitment from all parties in the design process to work in a collaborative way to achieve Passivhaus as a key target
7. There was a commitment from the contractor's supply chain to work in a collaborative way to achieve Passivhaus as a key target
8. Additional support was given to the contractor and sub-contractors in the form of toolbox talks and training
9. Additional site inspections were carried out to assist the contractor in achieving the higher construction standards
10. Interim airtightness tests were carried out early in the construction process, rather than solely at completion
11. Commissioning was overseen and carefully checked

Simple measures for Energy Efficient Schools
Whether or not the full Passivhaus methodology is adopted, here are some simple ways to improve the energy performance of new schools, whether they are being built by the Council or by private developers:

1. Focus on creating an efficient 'Form Factor' - that is minimise the total area of external fabric compared to the useful internal floor area. To achieve a lower form factor ratio requires a more compact form and less complexity of shape. This results in a more energy efficient building, which has less heat loss area, therefore requires less insulation, and costs less to build.

2. Assess the overall form and orientation carefully, to optimise daylighting without creating glare (to reduce reliance on artificial lighting) and control solar gain (to maximise useful solar gain, but prevent unhelpful overheating. For example south facing glazing can be simply and cost effectively controlled with brieze soleil, whereas solar gain on large or areas of east or west glazing is very difficult to control.

3. Avoid unnecessary complexity of detailing by focussing on creating simpler more robust details, giving particular attention to making them airtight. Simpler details are cheaper and easier to build. It isn't possible to design to a specific airtightness of 10, or 5, or 1 ach @ 50 Pascals, instead focus on designing to achieve the best possible airtightness that you can. Better airtightness will reduce energy consumption.

4. Design out thermal bridges in details by avoiding unnecessary penetrations through the thermal envelope - particularly at foundations, around windows, and at eaves.

5. Improve the basic insulation levels with the fabric - this can often be a cost effective way of improving performance, especially when combined with improved airtightness and reduced thermal bridging

6. Simplify the services systems - opt for quick response wet radiator systems with localised thermostatic control rather than slow response underfloor heating.

7. Simplify controls systems - avoid over complex centralised BMS systems, and opt for simple localised controls for heating and lighting.

8. Avoid reliance on natural (aka random) ventilation in winter, and if possible opt for mechanical ventilation with heat recovery. This ensures good levels of healthy fresh air, without loss of heat or discomfort caused by draughts. MVHR can be centralised for a whole school or wing, or localised in classrooms

9. Do all of the above items, to reduce energy consumption, before adding renewables to offset energy that shouldn't be being used.

10. Use PHPP (the passivhaus planning package) as a design tool to help optimise your design. Whether or not you are actually trying to achieve Passivhaus, it will assist in making a more cost effective and energy efficient building.