BBP | BETTER BUILDINGS PARTNERSHIP

DESIGN FOR PERFORMANCE

A new approach to delivering energy efficient offices in the UK

JUNE 2019

Foreword

At the Better Buildings Partnership, we have been working for over a decade to help our members improve the energy performance of their property portfolios. These efforts, whilst highlighting and supporting industry leadership, have been significantly hampered by a number of key issues:

- The regulations intended to achieve this outcome are failing - they secure energy efficiency in theory but not in practice.
- Existing voluntary schemes examine design intent, but rarely check or verify whether this intent delivers buildings that perform better.
- Data on actual operational performance is not easily obtainable or delineated to ensure appropriate accountability for performance and drive improvement.
- Operational performance is not reported upon and is therefore invisible to the market, most especially investors and occupiers.

In summary, the UK has a design-for-compliance culture which has led to the well-known 'performance gap' that exists between original design intent and how a building actually performs in-use.

In contrast, Australia has had a system to measure and rate the operational efficiency of its commercial offices since 1999 - NABERS. The scheme now covers 86% of the office market and the energy intensity of landlord services has improved by 36% since 2010. Put simply, Australia has learnt to deliver far better office buildings than those in the UK, driven by the transparency of the NABERS rating system and the clear market benefits it brings.

When you witness market transformation on such a scale, you naturally ask - What made it so successful? And can it be replicated in the UK? This is exactly what the Design for Performance initiative set out to discover.

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Over the past three years, a Feasibility Study, followed by a series of pilots on live office developments in the UK have demonstrated that not only is it possible to introduce a "design-for-performance" approach for new offices in the UK, but it is desperately needed if the UK real estate sector is to deliver better buildings.

It has always been a mystery to me why performance in any other industry is measured by outcomes and yet, in the real estate sector, we seem satisfied to equate performance with intent. This approach is no longer fit for purpose. This project has shown that buildings that are "designed to perform" are better designed, better delivered and better operated.

The project has also demonstrated that it is feasible and, indeed, desirable, to establish a scheme to verify performance in-use in the UK. We challenge the industry to collaborate and support the future development of a scheme to ensure that the industry delivers on the promises it makes.

Sarah Ratcliffe
Chief Executive Officer
Better Buildings Partnership

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Introduction

The UK commercial real estate sector is coming under increasing scrutiny concerning its impact on the environment and wider society. Investors, occupiers and the Government are all beginning to acknowledge and appreciate the limitations of solely using design-based criteria in assessing these impacts for investment and policy decisions. As a result, an increasing weight is being placed on how buildings perform in-use.

The Design for Performance (DfP) initiative is an industry funded and backed project established to tackle the 'performance gap' and provide an approach, based on measurable performance outcomes, to ensure new office developments deliver on their design intent. The concept is not new, the project emulates international best-practice demonstrated by the hugely successful NABERS Energy Rating and Commitment Agreement that has transformed the prime office sector in Australia.

The key difference between the design approaches witnessed in Australia and the UK is simple. The Australian approach focuses on operational performance outcomes; embedding these in targets, contractual requirements, design tools and independent verification assessments. In comparison, the UK approach sets compliance as its target, with operational performance rarely reviewed.

As part of a 3-year programme of work, the DfP initiative has reviewed the success factors of the approach witnessed in Australia and tested the applicability of developing such a 'design-for-performance' approach in the UK.

The findings show that not only are there no technical reasons why a design-for-performance approach cannot be introduced in the UK, but there is also a clear need for it; with benefits accruing to a wide range of stakeholders, including investors, property owners, occupiers and engineering firms.

SUCCESS FACTORS OF A DESIGN-FOR-PERFORMANCE APPROACH

- AN OPERATIONAL PERFORMANCE TARGET & RATING SYSTEM
- A CLEAR BASE BUILDING DEFINITION
- ADVANCED SIMULATION
- INDEPENDENT DESIGN REVIEWS
- INTENSIVE COMMISSIONING & FINE-TUNING
- HIGHLY SKILLED PRACTITIONERS
- STRONG MARKET DRIVERS

The DfP initiative will now be embarking on a new phase of work to develop the key elements required to implement a design-for-performance approach in the UK. This will include:

- Developing a rating scheme with associated rules, tools and assessment and quality assurance processes.
- Identifying market pioneers who are willing to develop the approach and commit to setting performance targets for new development projects.
- Identifying training partners who will help upskill the industry.
- Working with industry bodies to ensure alignment and synergy with wider initiatives and activities.
- Identifying a Scheme Administrator with the responsibility to oversee and administer a scheme in the UK.

This report provides a summary of the work undertaken to date, highlighting the lessons learnt from a Feasibility Study and Pilot Programme,and how a scheme could be developed for the UK.

The UK's Design-for-Compliance Culture

The design of new buildings in the UK is driven by a wide range of regulations that seek to deliver energy efficiency. However, these regulations are failing to deliver their intended outcome. They secure performance in theory but not in practice.

The energy efficiency of new office buildings in the UK is subject to Building Regulations Part L and represented in market transactions by Energy Performance Certificates (EPCs). Both these policy mechanisms focus on the theoretical performance of a building's design under standard conditions of use, but pay little attention to how the building actually performs in operation.

The consequence has been a design-for-compliance culture, where design teams focus on improving the results predicted by a 'compliance model' (an assessment of input-based criteria), rather than attempting to anticipate and improve how the building will actually perform in operation (an assessment of output-based criteria).

The UK's design-for-compliance culture is reinforced by the fact that a building's operational performance is not expected to be measured, so actual outcomes are never compared against the original predictions. This lack of a feed-back loop within the process of building design has led to the creation of a 'performance gap' between a building's theoretical performance and its actual performance.

There is strong evidence to show that the continued and increased use of input-based design ratings will not deliver the full energy efficiency potential available for both new and existing buildings in the UK. The BBP's own research via the Real Estate Environmental Benchmark suggests that there is no correlation between how efficiently an office building uses energy and its EPC rating (see Figure 1).

The failure of the current regulatory framework to drive energy efficiency creates a risk of additional regulations being introduced that still do not deliver the desired outcomes, and only add further compliance costs.

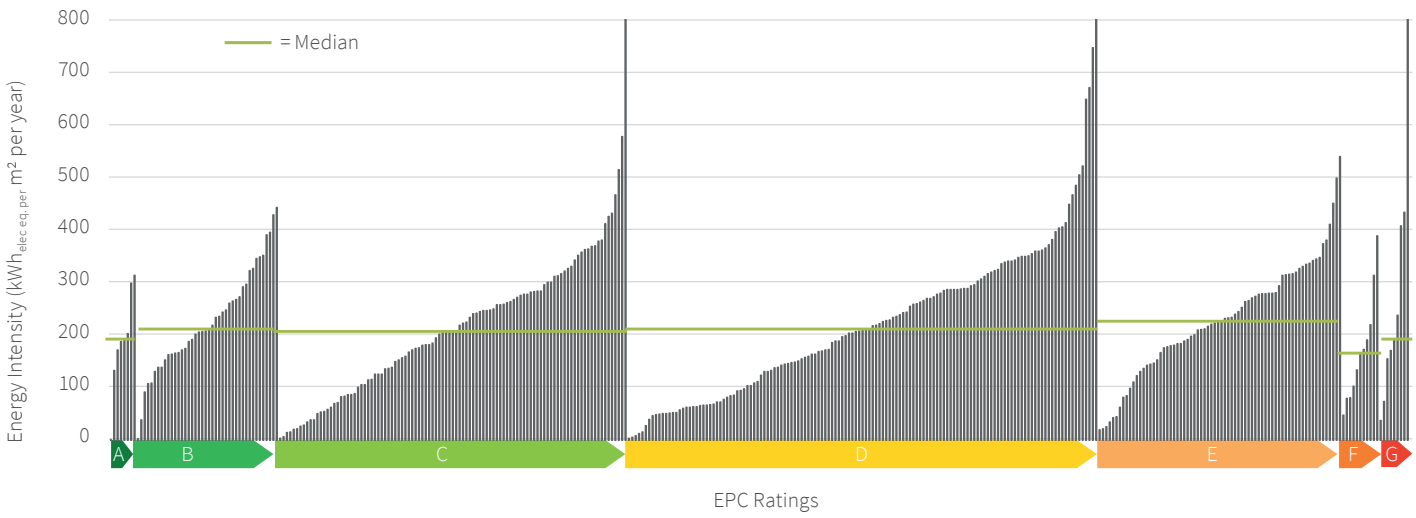
There is a clear need for a change of approach, whereby:

1. designers are encouraged and given the opportunity to anticipate and improve how building systems will perform in-use, and;

2. an appropriate and transparent way of measuring operational performance, providing the necessary feedback to inform future design considerations, drives continual improvement and influence market behaviour.

Such an approach would provide the impetus to dislodge the UK real estate sector from its current design-for-compliance culture and transform the way buildings are designed; fostering a design-for-performance culture.

Figure 1. Office energy intensity ($kWh_{elec.eq.per}$ m^2 (NLA) per year) by EPC rating. Each grey bar represents a single office building's energy intensity over the course of a year. (Source Real Estate Environmental Benchmark 2017, Better Buildings Partnership)



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Australia's Design-for-Performance Culture

In direct contrast to the UK, Australia started by introducing an energy label that rated the operational performance of existing properties. The scheme, now known as NABERS, triggered the start of its design-for-performance culture. The effect has been transformational, with new and existing offices compared using a simple metric that sets the agenda for investment decisions by investors, developers and occupiers alike.

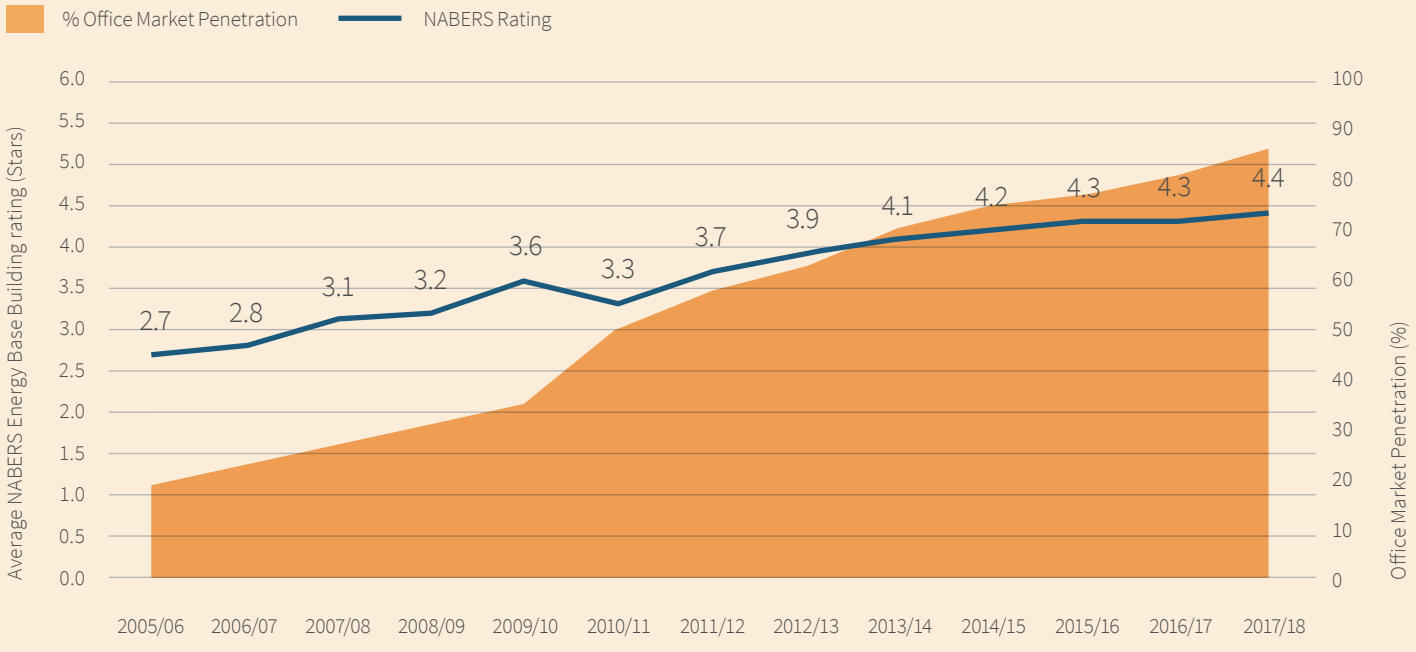
Stimulating a system for disclosure

In 1998, a voluntary operational rating system that benchmarked the energy used by a landlord to service an office building (referred to as a base building rating) was launched in Australia. Initially known as the Australian Building Greenhouse Rating (ABGR) but now known as NABERS, it was used by Government tenants as a way of specifying energy efficient office space through a simple star rating scale, with 6 Stars being the best and 1 Star being the lowest possible rating.

As a result of its success and voluntary take up by the wider Australian real estate market, in 2010 the Australian Government introduced the Building Energy Efficiency Disclosure (BEED) Act. This made it a legal requirement for all commercial office buildings with tenancies over 2,000m^2 to obtain and disclose a valid NABERS Energy Base Building or Whole Building rating at the point of sale or lease. In 2017, the threshold was lowered to 1,000m^2.

The rating system, coupled with the mandatory disclosure requirements, has created an environment where base building energy ratings have become a core business KPI, allowing property owners, investors and occupiers to easily understand how energy efficient office buildings are in operation. Now covering 86% of the office sector by floor area, it has had a transformational impact on the energy performance of office buildings. Since the introduction of the BEED Act in 2010, the average energy intensity of all base building rated offices has improved by 36%, with the average Star Rating increasing from 3.3 to 4.4[1] (See Figure 2).

Figure 2. Chart highlighting average NABERS Energy Base Building ratings and office market penetration over time.



Creating a design-for-performance culture

Whilst initially focussed on existing buildings, the NABERS rating scheme has also created a change in the approach to the design of new office buildings and major refurbishments through the development of the NABERS Energy Commitment Agreement.

Established in 2002, the NABERS Energy Commitment Agreement provides a framework for property owners and developers that commits design teams and contractors to design and deliver a new or refurbished office building that achieves a targeted NABERS Energy Base Building rating. Such a process allows a NABERS rating to be used as a verifiable procurement standard where the product is the completed building when occupied and in operation.

It essentially comprises of the following requirements:

1. A public commitment from the developer to a target NABERS Energy Base Building rating (operational performance target).

2. A design process informed by advanced simulation to demonstrate that the building is theoretically capable of achieving the required rating under a variety of plausible scenarios for how occupiers may use the building.

3. An Independent Design Review to scrutinise the design and the simulation studies and judge whether the building is likely to achieve its target.

4. An intensive commissioning and fine-tuning programme during early operation, including tracking base building performance against the target.

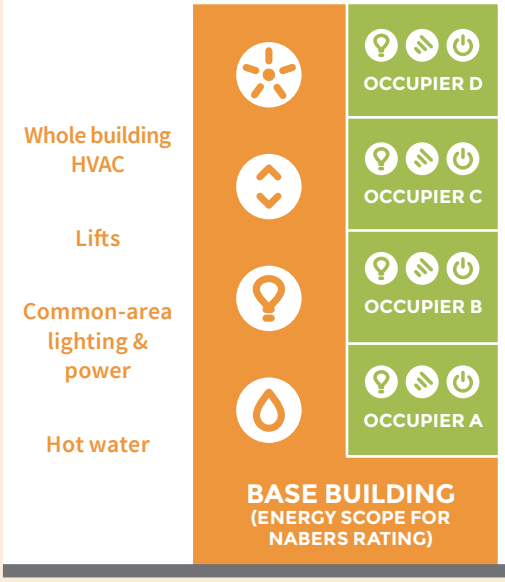
5. A post-construction NABERS Energy Base Building rating, covering 12 months of data once the building is ≥75% occupied, to validate the achieved operational performance.

When the NABERS Commitment Agreement was first introduced, there was little understanding of how to design and deliver a target NABERS Energy rating for a new office building. However, quite quickly, State Government occupiers started to set targets of 4.5 Stars for new developments. Whilst a rating of this level was relatively rare at that time for existing buildings, it was deemed a suitable target for a new building where it was assumed it would be easier to achieve higher levels of energy efficiency. This sent a clear signal to property developers and investors regarding the future trajectory of market sentiment.

What is base building energy?

Base building energy relates to the energy used for landlord supplied services and is used to define the scope of energy included within a NABERS Energy Base Building rating. The scope is comprised of:

- All energy associated with the general heating, ventilation and air-conditioning (HVAC) system provided to service the whole building;
- Light and power to non-lettable spaces (which includes the entry foyer, most lift lobbies, back of house and base building amenities);
- Lifts;
- External lighting;
- Car park lighting and ventilation, where car parks are provided for the sole use of tenants;
- All other services provided for general use of the tenants (most often this is a condenser water loop provided for tenants to attach supplementary air-conditioning);
- Domestic hot water provided centrally and/or to base building amenities (local domestic hot water within tenant spaces is not captured within the rating); and
- Fuel used for back-up generators.



In 2006, the Property Council of Australia introduced minimum NABERS Energy Base Building ratings into their definitions of new offices: 4.5 Stars for grade A and 4 Stars for grade B. And by 2006/07, the Australian Commonwealth Government had adopted a 4.5 Star rating as a minimum requirement for all newly owned and leased office space >2,000m^2. These combined actions effectively created a minimum standard for the industry.

Leading property owners and developers also played an important role in driving innovation by competing with one another to be the first to achieve major rating milestones. For example, Mirvac was the first company to achieve a NABERS 6 Star Energy Base Building rating in 2014 at Sirius House in Canberra, a 46,000m^2 office, housing the Australian Government Department of Health and Aging as the sole tenant.

To date, over 230 office developments have set a target of NABERS Energy 4.5 Stars or higher with that number only set to increase[1]. In May 2018, the City of Sydney announced that in light of its net zero 2050 target, the minimum standard for new office developments in the Sydney central business district will be 5.5 Stars (a rating currently achieved by less than 10% of the office market[1]), continuing to demonstrate the supporting role Central, State and City Government can play in driving the energy efficiency agenda.

By focussing on performance outcomes, as opposed to prescriptive design requirements, the NABERS approach has fostered an industry that embraces innovation and is continually pushing the boundaries of base building energy use. It has stimulated market demand, facilitated progressive policy development and ultimately, delivered better buildings for occupiers and investors.

The DfP initiative set out to examine and explore precisely this design-for-performance culture and its replicability in the UK market.

Expanding beyond base building energy

Over the course of NABERS' history a suite of additional operational ratings have also been developed. This includes an expansion in:

- scope to develop individual tenant and whole building ratings to complement base building ratings;
- property areas to cover shopping centres, hotels, apartment buildings and data centres;
- impact areas to cover water, waste and indoor air quality.

For more information see www.nabers.gov.au

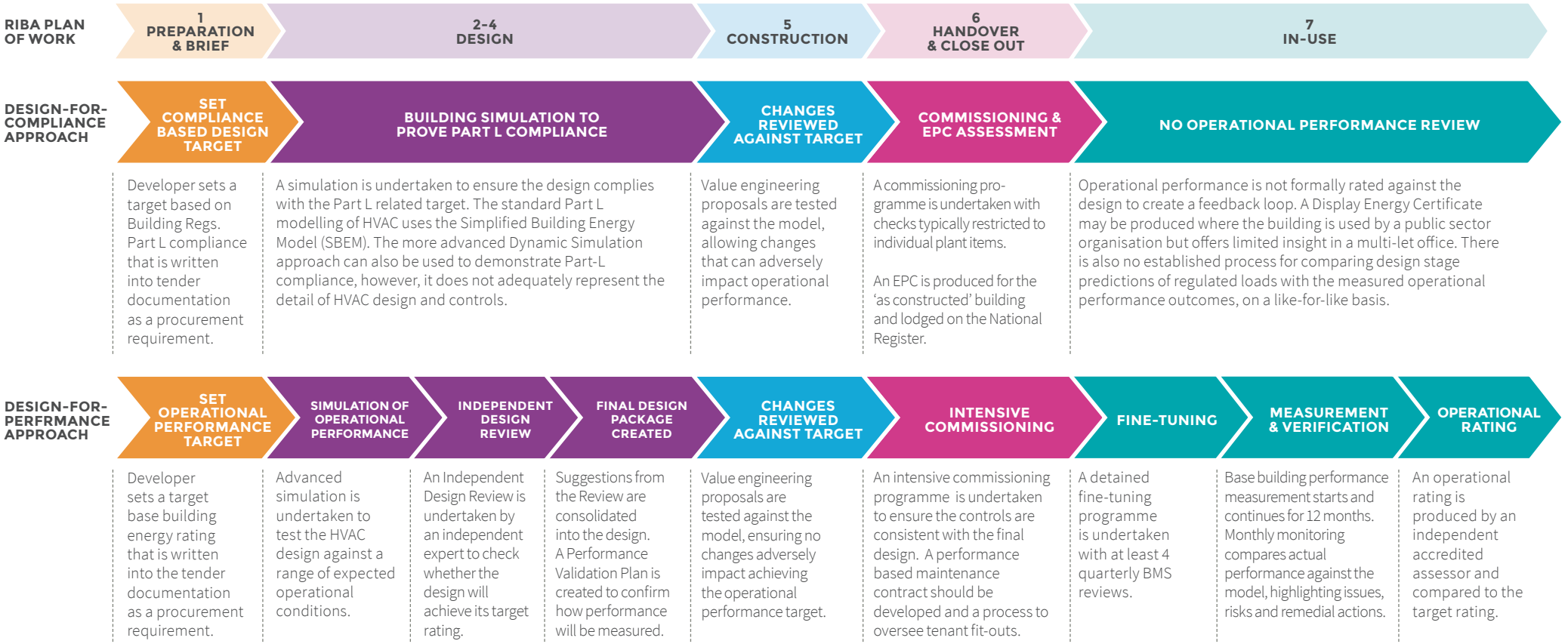
Sirius House, Canberra. The first office to achieve a NABERS 6 Star Energy rating. © MIRVAC

What is a Design-for-Performance Approach?

If the UK is to mirror the NABERS Commitment Agreement framework, a new approach to the design and delivery of office buildings is needed. One that moves away from the current design-for-compliance approach to one that embraces a design-for-performance approach.

Figure 3 below summarises what a design-for-performance approach would involve compared to the current design-for-compliance approach, set against the stages of the RIBA Plan of Work.

Figure 3 A comparison of the key elements of a design-for-performance approach to the current design-for-compliance approach, set against the stages of the RIBA Plan of Work.



Benefits of a Design-for-Performance Approach

The adoption of a design-for-performance approach provides benefits to all stakeholders involved.

INVESTORS & LENDERS

It provides a simple yet robust metric to compare and target energy efficient buildings and portfolios, as well as gauge occupier demand. In the Australian real estate market, investors target office buildings with better base building ratings. This is due to an increase in demand from occupiers that leads to higher yields, through higher income returns and stronger capital growth. It also provides a useful tool for green bond issuers to qualify assets on the basis of operational energy use and associated carbon emissions.

DEVELOPERS & PROPERTY OWNERS

It provides an outcome-based metric that can be used as a procurement standard for the construction of new offices. This provides assurances that what is specified will be delivered, as well as confidence to reference target ratings when marketing the property to prospective occupiers as an indicator of quality and operational costs. Not only can such an approach distinguish an office in a competitive market, but based on evidence from Australia, strong occupier demand will help attract and retain good quality occupiers and have a positive impact on property value.

Capital costs can also be reduced via the advanced simulation of HVAC systems, by empowering specifiers to select appropriately sized plant and equipment.

It can also provide an assured pathway to help fulfil corporate objectives related to energy use and carbon, and the ability to respond to investor demands for greater transparency.

OCCUPIERS

It provides certainty to occupiers signing a pre-let that the building will live up to its promise, through the requirements of a verified, independent assessment of the building's energy performance. A more energy efficient base building will reduce occupier utility costs and an operational energy rating also offers opportunities to fulfil corporate commitments in a transparent manner via public disclosure of building performance.

DESIGNERS & CONTRACTORS

It provides the ability for industry practitioners responsible for the design and development of new offices to demonstrate that they have the skills and experience to deliver buildings that meet a target operational performance. Those who are successful will be able to differentiate themselves as leaders within a competitive market. Designers should relish the challenge of achieving performance targets and receiving feedback on how their designs truly perform, enhancing job satisfaction and career fulfilment.

PROPERTY & FACILITY MANAGERS

It can continue to provide benefits once the building is fully occupied. The on-going use of an operational rating can provide clarity to both property owners and managing agents in relation to expectations and requirements of each party. A rating can be used as a transparent way of agreeing a target and demonstrating performance against it. For a property owner, it provides a potential procurement KPI when outsourcing property management services. For property and facilities managers, it provides the opportunity to differentiate themselves within the market, based on their ability to deliver an effective performance-based service offering.

GOVERNMENT

It can complement the UK's regulatory landscape from both a planning perspective for new office developments, as well as disclosure requirements for existing buildings. Such an approach will support the UK's 2050 zero carbon target, as well as it's Industrial and Clean Growth Strategies in terms of improving energy productivity, reducing carbon emissions and increasing energy security.

Key Elements for Success

A Feasibility Study was undertaken as part of the DfP initiative to identify the key elements of the NABERS Energy Rating and Commitment Agreement framework that have contributed greatest to its success. These are summarised below.

DfP Feasibility Study

In 2016, a desktop-based Feasibility Study was undertaken to help understand the development and application of NABERS within the Australian real estate market and identify the key elements that have contributed to its success. This provided the initial scoping work for assessing whether such a scheme could be replicated for the UK market. The full report is available here[2].

AN OPERATIONAL PERFORMANCE TARGET & RATING SYSTEM

The ability for developers to set operational performance targets for new office developments has transformed the approach and importance given to HVAC design in Australia. The simple existence of a measurable outcome has increased the level of scrutiny given to HVAC design throughout the entire delivery supply chain. This has, in turn, dramatically improved the design skills within the industry and stimulated innovation.

It is now common place for base building performance targets to be included within contractual arrangements for new office developments, and sufficient experience and knowledge now exists within the industry to routinely deliver against a NABERS Energy 4.5 Star target or higher. This gives investors, property owners and occupiers the confidence to know what will be delivered to them.

A CLEAR BASE BUILDING DEFINITION

The ability to differentiate the energy used for base building services and that for occupier activities has been pivotal in providing a metric that is appropriate for and accepted by the Australian commercial real estate market.

The delineation of energy consumption between property owner and occupier, together with owners and their supply chain having control and responsibility for base building services, has resulted in property owners having the ability to influence and take ownership of a base building rating. This approach allows buildings to be fairly compared against one another, providing transparency and a point of differentiation for investors and occupiers seeking high quality, energy efficient properties. The clear definition of base building energy has also helped standardise both the utility metering provided and the extent of sub-metering within the Australian prime office stock to allow for the accurate measurement of base building energy performance.

ADVANCED SIMULATION

The detailed simulation of HVAC plant and controls as an integral part of building modelling activities has been central to the ability to deliver against operational performance targets in Australia. Advanced simulation is used to test the HVAC design against a range of expected operational conditions to provide confidence that the performance target can be met. These detailed model predictions provide important evidence for the Independent Design Review, as well as a continual reference point for value engineering considerations, commissioning, fine-tuning and in-use monitoring once the building is occupied.

Importantly for property owners and developers, the use of "advanced simulation", coupled with feedback and learning from previous projects, has also helped to reduce construction costs by ensuring plant and systems are correctly sized for the calculated plausible demands to be placed upon them. This benefit should outweigh the additional costs required to undertake the modelling work.

If the UK were to adopt the advanced simulation approach to modelling, not only will the skills to deliver such work be required, but also a step change in the level of priority given to modelling. In Australia, HVAC modellers enjoy a high status in the design team, with the results deployed as a core consideration for the design, commissioning and fine-tuning of the building, whereas in the UK, the modelling process is very much perceived as a back room, tick-box compliance exercise.

INDEPENDENT DESIGN REVIEWS

In Australia, the NABERS Commitment Agreement requires an Independent Design Review (IDR) to be undertaken by a member of a prequalified panel of reviewers with experience in both the design and post-construction operation of office buildings. It scrutinises the design, metering plan and the advanced simulation outputs, forcing designers to pay more serious attention to HVAC plant selection, design and control. The overarching objectives of an IDR are to:

- identify risks and opportunities in relation to the building achieving its target base building rating; and
- identify and suggest potential improvements to the current design.

The exact timing of an IDR can vary according to project circumstances. Earlier reviews give more opportunity for design changes to be made before decisions become fixed. On the other hand, reviews at a later stage are more detailed as the design is more fully formed, but opportunities for change are more limited and therefore more focussed on controls.

The introduction of IDRs was not always plain sailing in Australia. Advice could be and was ignored, as well as reviews often taking place too late in the design process for meaningful changes to be able to be implemented. However, beyond its impact on any one project, anecdotal feedback from practitioners is that the greatest impact of IDRs has been to educate and upskill the industry by placing a large amount of design advice in front of the design team, which almost inevitably permeates into the next project. As a result, there has been a significant shift in the approach to HVAC design since the introduction of IDRs.

INTENSIVE COMMISSIONING & FINE-TUNING

Even with a good design, informed by advanced simulation and high-quality construction, the application of a methodical and rigorous programme of commissioning and post-occupancy fine-tuning is essential to the successful delivery of an operational performance target.

For those undertaking Commitment Agreements in Australia, commissioning is a key component of a contractor's deliverables, and one that has evolved and been refined over time. A key objective of the commissioning process is to ensure the building's controls have been set-up in a consistent manner to the building model and in-line with the intentions of how the building will be operated.

Following handover, a comprehensive fine-tuning programme is initiated that typically lasts for the first two years of operation (determined partly by how long it takes to reach full occupancy). The building model is a key tool to support this and involves the delivery team producing monthly reports comparing sub-metered performance to simulated predictions. This process helps identify whether the building is on track to achieve its performance target, and if not, what remedial work is required. Several fine-tuning exercises on the BMS are also essential over the first year of operation, ensuring different occupancy patterns and seasonal weather conditions are catered for effectively and efficiently.

It is also important to appreciate the length of time required to get a new building to operate as intended. In Australia, it can take up to two years for a building to meet its operational performance target, a period of time far longer than is spent in the UK on fine-tuning and aftercare, not least because there is no operational energy performance target for the supply chain to deliver against.

HIGHLY SKILLED PRACTITIONERS

Since its introduction in 2002, the application of NABERS Commitment Agreements in Australia has not only helped to deliver better buildings, but has also helped to improve the skill base, particularly for building services design and contracting industries. However, the length of time it has taken to foster these skills should not be underplayed. The industry had to learn by doing, taking approximately five years for designers and contractors to learn, often the hard way, the inefficient practices embedded within the industry. Then another five years shifting mindsets and developing new approaches. But in doing so, Australia now boasts a competitive market with a large pool of skilled practitioners that developers can choose from.

STRONG MARKET DRIVERS

The NABERS programme has enjoyed strong market demand from its inception. The power and influence Australian Government agencies had as a major occupier within the real estate market ensured that when the NABERS programme first launched commercial property owners had no choice but to rate their properties. Over time, that demand strengthened with other occupiers setting targets as part their corporate CSR commitments, coupled with the competitive nature of property owners attempting to out-perform each other by bringing the highest rating buildings to market. This helped ensure NABERS ratings were used for prestige offices at the top end of the market. Finally the introduction of the Building Energy Efficiency Disclosure (BEED) Act in 2010 provided the driver for the wider office market by setting the legal requirement for all offices over 2,000 m² to have a NABERS rating for sale or letting.

Could a Design-for-Performance Approach Work in the UK?

Following the Feasibility Study, a Pilot Programme to test the key success factors of a design-for-performance approach was undertaken on live development projects, with the aim of assessing their viability and applicability in the UK.

Six office developments were selected that were at varying stages of their design, construction and operation, providing the necessary conditions to test a design-for-performance approach and identify challenges across the whole development life-cycle within a short space of time (See Table 1). The key findings are summarised below.

DfP Pilot Programme Technical Report

Following the publication of the DfP Feasibility Study, an 18-month research programme was undertaken to test the key success factors of the NABERS rating and Commitment Agreement framework on real-life development projects in the UK. The aim was to provide a sound evidence base to inform how a scheme could be implemented and successfully operate in the UK. The full report with detailed findings from the individual pilot projects is available here[3].

Table 1 A table summarising the key elements of success tested on various pilot buildings that were at varying states of the development cycle

Pilot Sponsor	RIBA Stage	Operational Targets	Base Building Metering	Advanced Simulation	Independent Design Review	Commissioning & Fine-tuning	Monitoring & Verification	Operational Rating
British Land	**1-2** (Refurbishment)	✓	✓	✓			✓	✓
LGIM Real Assets	**3-4**	✓	✓	✓	✓	✓		
Nuveen Real Estate	**3-4** (Refurbishment)	✓	✓	✓	✓	✓		
Stanhope	**3-4**	✓	✓	✓				
Transport for London	**7**	✓	✓	✓	✓	✓	✓	✓
The Crown Estate	**7**	✓	✓			✓	✓	✓

1. OPERATIONAL PERFORMANCE TARGETS ARE NOT BEING SPECIFIED

A base building operational energy target is the key KPI that provides the reference point at every stage of the project from design concept through to operation, yet no such performance targets were specified within contractual requirements for any of the pilot buildings. This was fully anticipated given the lack of drivers and tools available within the UK commercial real estate market to facilitate such an approach, however, it does illustrate the step change that is required. The absence of this crucial first step means that the priority and level of scrutiny that should be placed on operational energy performance is not filtered down through the supply chain.

Interestingly, one pilot building had tried to set an operational energy performance target, however, failed to secure such a contractual measure. This was because the operational target being attempted was for the entire energy use of the building. The variables to consider were therefore too great for the contractor to have any confidence in meeting the target. Had a design-for-performance approach, using base building targets, been available at the time, it is very possible such a target could have been agreed. Such an example highlights the importance of being able to separate out the energy consumption that the property owner is responsible for (i.e. base building), and that which the occupier is responsible for (i.e. lighting and IT equipment).

2. CURRENT METERING IS NOT DESIGNED TO MEASURE BASE BUILDING PERFORMANCE

It is common in the UK for individual office buildings to have just one main meter for each energy utility. For base building energy consumption to be measured, it is therefore necessary for appropriate sub-metering to be installed.

When reviewing the metering systems of the three operational pilot buildings, none were able to easily measure base building performance. This was a result of a lack of sub-metering, as well as insufficiently detailed metering plans and meter labelling to easily identify what each meter was measuring. Consequently, energy auditing processes had to be applied to determine how to use the existing metering to measure base building energy consumption.

Issues were also identified in relation to the extensiveness of sub-metering when reviewing the meter plans of the three pilot buildings that were at the design stage. A particular concern related to the lack of sub-metering of fan coil unit motors.

Such findings demonstrate that current sub-metering design practices in the UK are not well aligned with the need to measure base building performance and a step-change in approach is needed. However, this finding should come as no surprise given that none of the pilot buildings' metering systems had been designed with the objective of measuring base building energy.

To overcome this challenge and increase the ease and frequency with which base building energy can be measured in the UK, guidance will be needed for metering designers. CIBSE TM39: Building Energy Metering would be the recommended source to provide this guidance. However, it will also take time for the practical knowledge and experience of how to deliver such metering systems to develop.

3. THE UK IS UNDERUTILISING SIMULATION

The use of advanced simulation as a strategic tool within the design process is a fundamental aspect of a design-for-performance approach. A key differentiating characteristic to current practices is the inclusion of the HVAC system and its controls within the model. This addition enables the model to represent how the building will be conditioned under realistic operating conditions, taking into account part load efficiencies and losses, to produce an accurate estimate of base building energy use down to the resolution of individual sub-meters.

A question that the Pilot Programme wanted to answer was whether the use of advanced simulation that included HVAC and controls could be used to accurately predict operational energy use in a UK office building. To help answer this, the existing models for five pilot buildings were reviewed.

All of the building models reviewed went beyond Building Regulations Part L requirements, and several used CIBSE's TM54 modelling methodology, an approach widely viewed as UK best practice. However, no pilot building had undertaken modelling on the HVAC system and controls to the level of sophistication that would be required as part of a NABERS Commitment Agreement. The simple reason being it was not requested as part of the design specification.

With no pilot building models built to the level of sophistication required, an advanced simulation model was developed for one of the pilot buildings from scratch as a proof of concept. The pilot building was built in 2006 and therefore provided the opportunity to compare the model against actual operational data. The work was undertaken by Built Physics with practical support from British Land and Broadgate Estates and is believed to be the first of its kind in the UK.

Once developed, the model was successfully able to represent in detail how the building should operate compared to how it was being operated in practice. Such a finding demonstrates that a building model can be used as part of the design process to successfully predict to a satisfactory level of detail how a building will perform in-use, in the same way as witnessed in Australia. Many would consider this the 'holy grail' to providing designers and their clients assurances regarding operational performance outcomes in a market where occupiers specify a desired base building rating.

Interestingly, the model suggested that the building's chiller capacity had been over specified, and had this been a new development, HVAC capital expenditure could have been reduced. In addition, British Land are continuing to use the model as a fine-tuning tool to identify further energy efficiency opportunities, demonstrating the added value such a tool can provide.

4. DESIGNS WOULD BENEFIT FROM INDEPENDENT DESIGN REVIEWS

Independent Design Reviews (IDRs) have been a useful process in Australia to confirm that a design will deliver the intended operational performance target, as well as provide valuable upskilling and education for the HVAC design industry.

To test their applicability in the UK, IDRs were undertaken on four pilot buildings (the fourth is not cited in Table 1). In each case the IDRs highlighted clear opportunities to improve the energy performance of the building. In some cases, these would require design changes and in other cases, they required more extensive attention to be given to fine-tuning and commissioning.

Examples identified included:

1. Opportunities to make chilled water and hot water flows variable temperature;
2. Opportunities to introduce variable flow outside air;
3. Opportunities to use variable pressure control;
4. Improvements to LED lighting system specification and commissioning processes;
5. Improvements to sensor locations;
6. Improvements to sub-metering strategies.

In more general terms, the IDRs also identified design trends that appear to be default solutions in the UK, that are not common place in Australia. Examples include the use of fan coils, fixed speed pumps that run at maximum load when in operation, constant volume outside air delivery and fixed chilled and hot water supply temperatures for air-conditioning delivery. Such systems identified within the pilot buildings did not have the flexibility to service individual tenancies separately and, therefore, were unable to respond efficiently to variable demands caused by changing occupancy levels over the course of a day, differing operating hours in different tenancies or the presence of voids.

Another significant difference appears to be the the limited control the landlord has over base building services within an occupier's demise. This directly impacts upon the ability of the HVAC system to be operated efficiently and, in the worst instance, can lead to central plant being operated 24 hours a day, just in case occupier demand occurs.

The findings demonstrate that buildings in the UK would benefit from the use of IDRs, with the approach aiding design teams in identifying opportunities that were not initially considered. In addition, on a much wider scale and over a much longer timeframe, there is opportunity for the IDR process to shift standard industry design practice towards HVAC systems that are increasingly flexible and efficient, in a similar way as has been witnessed in Australia.

5. DESIGNS ARE NOT INHERENTLY ENERGY INEFFICIENT – THEY JUST DON'T PERFORM AS INTENDED.

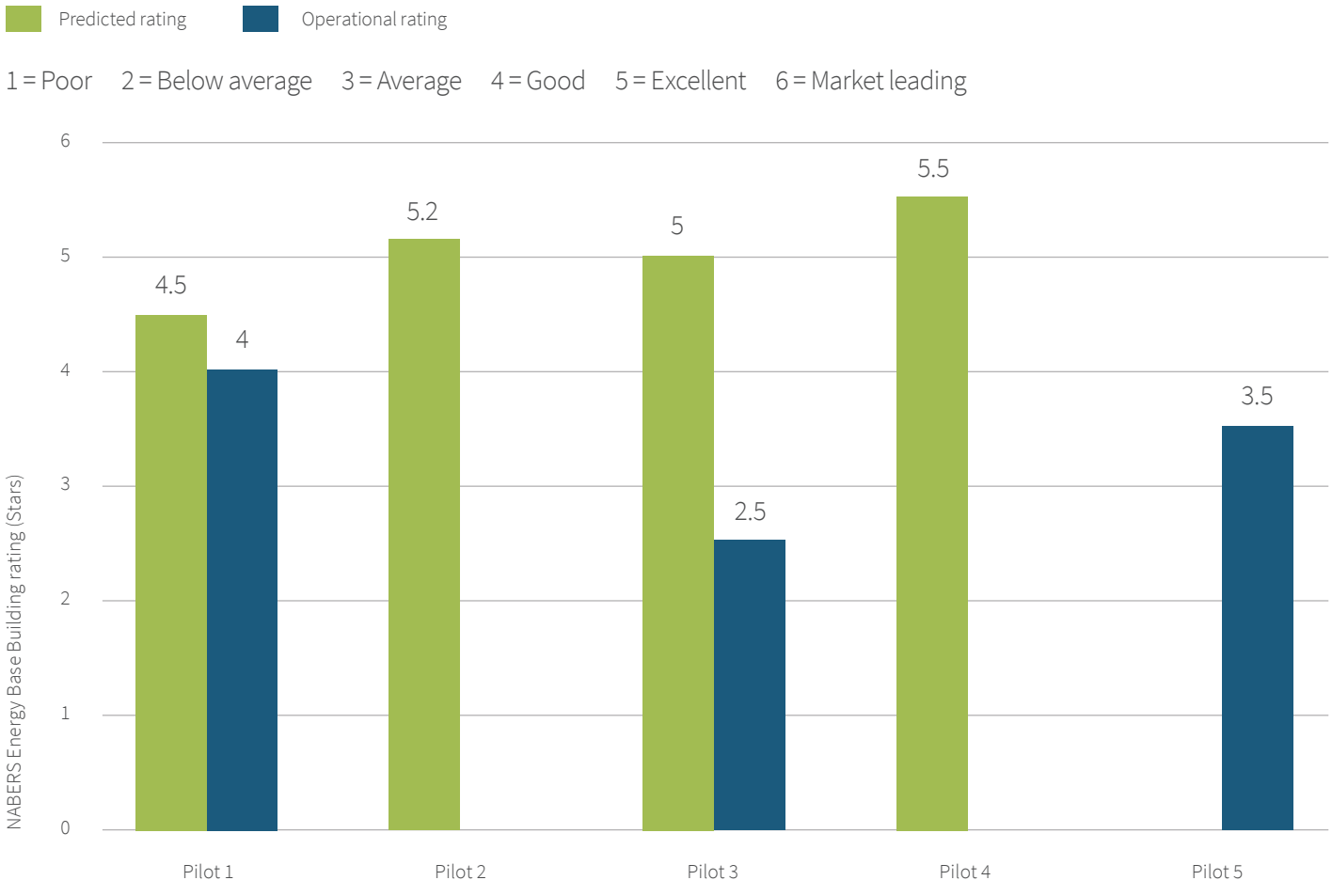
To gain a better understanding of whether the designs of new offices in the UK are less energy efficient in comparison to Australian designs, the building models of four pilot buildings were used to generate predicted NABERS Energy Base Building ratings.

Notwithstanding concerns about the quality of the building models, the results were encouraging with the four predicted ratings ranging between 4.5-5.5 Stars. Whilst such ratings for new office building designs would be at the lower end of current industry practice in Australia, they would not be out of place. These results should be viewed positively given that the UK office market has not had the market demand witnessed in Australia and that clear improvement opportunities were identified by the Independent Design Reviews. In addition, such ratings are further ahead than when Australia first implemented Commitment Agreements in 2002.

A less positive result was found when running NABERS ratings using actual operational energy data. In addition to the predicted NABERS Energy ratings, two pilot buildings had base building energy data available to run an operational rating. In both instances the operational ratings were poorer than the design ratings suggested they should be. One being 0.5 Stars lower, achieving a 4.0 Star rating, and the other being 2.5 Stars lower achieving a 2.5 Star rating. Separately, another pilot building undertook an operational rating and achieved 3.5 Stars but did not have a design rating to compare it against (See Figure 4).

The instance where operational energy performance is significantly worse than the target rating, would not typically occur in Australia, or if it did, would be rectified. And herein lies the fundamental difference between the Australian approach and what is witnessed in the UK – by setting, designing to and measuring against an operational target, the Australian target target is inevitably met (or at least, is very close to being met). This is simply not the case for the UK where the lack of transparency regarding operational performance masks management inefficiencies that result in buildings not achieving their full potential.

Figure 4 Comparison of pilot building NABERS Energy Base Building rating for designs vs operation



6. COMMISSIONING NEEDS A MORE HOLISTIC APPROACH

To assess the applicability of UK commissioning practices for a design-for-performance approach, the commissioning and fine-tuning regimes of two pilot buildings were compared against the typical practices that would be undertaken for a new office development in Australia.

In short, it was found that the commissioning and fine-tuning activities were not as extensive or as detailed as those found in Australia. Reviews picked up issues that would have been identified within Australian commissioning and fine-tuning assessments. These included:

- Main plant running 24 hours a day e.g. pumps, chillers and boilers;
- AHU dynamic volume control dampers time schedule not set to shut when the floor is unoccupied;
- Fan-coil units operating excessive hours e.g. 4am to 10pm; and
- Poor control of fan-coil units e.g. in heating mode during warm weather in summer.

Interestingly, a common theme emerged from the two pilot buildings' approach to commissioning. In both cases, individual items of plant were typically reviewed in isolation, as opposed to how the system operated holistically. Such an approach increases the risk of a scenario where individual plant items are functioning correctly, but the system as a whole is functioning inefficiently.

In Australia, detailed commissioning reviews and fine-tuning during the first two years of occupation is used to identify faults preventing the building from operating in accordance with the modelled design intent. Such commissioning regimes are built into the remits of all stakeholders involved, including MEP engineers, control engineers, managing agents and facilities managers, and ideally incentivised by performance-based maintenance contracts. This has resulted in a holistic approach to commissioning at a whole system level, however, the lack of an operational performance target and advanced simulation for reference in the UK, has meant that such an approach has not been possible.

Another key finding in relation to fine-tuning was the high skill level of the engineers available for BMS reviews in Australia. This was tested on one building by procuring the BMS reviews from Australian consultants working remotely with 'read-only' access to the BMS and sight of 'as completed' design drawings. The high standard of reporting delivered by these consultants was eye-opening for the Pilot Sponsor, and highlights that when a performance outcome is important in the market, skill levels rise to meet the need.

It is clear that lessons can be learned from the commissioning and fine-tuning regimes in Australia. However, the UK is well-placed to integrate such learnings through existing industry initiatives such as the BSRIA Soft Landings Framework.

7. THE UK HAS A SIMULATION SKILLS SHORTAGE

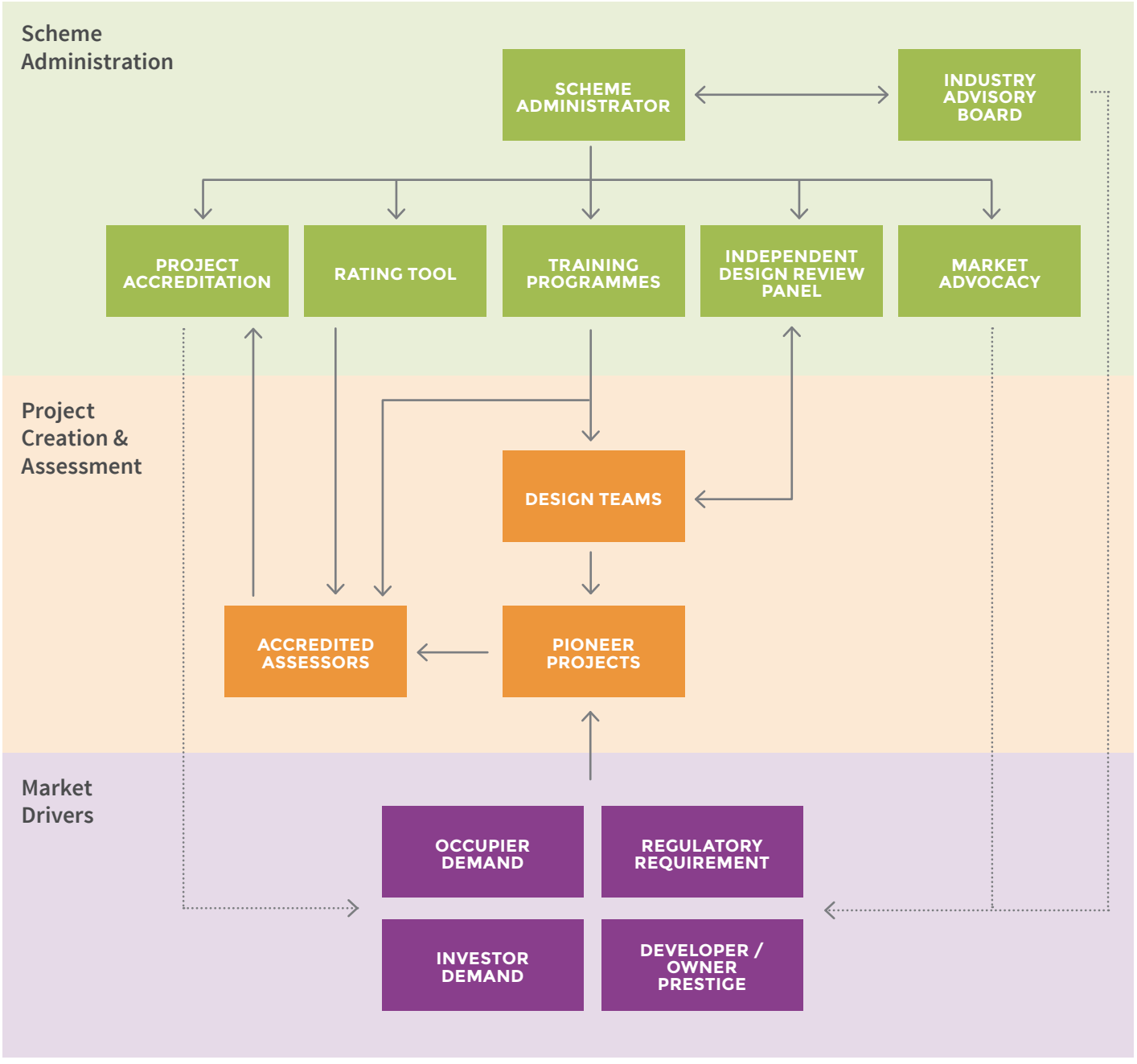
The low priority given to the simulation of HVAC systems and controls in the UK's current regulatory framework, combined with the knock-on effect of clients not requesting it, has led to a significant skills gap within the UK's design consulting community in their ability to deliver such work. Evidence of this was experienced when a number of Pilot Sponsors requested additional HVAC and controls simulation to be added to their existing modelling work.

Whilst this may prove challenging in the short term, positively, a number of specialists who are capable of providing such services exist in the UK. Such a position is very similar to the one the Australian market was in 15 years ago.

What is Needed to Implement a Design-for-Performance Approach?

The Feasibility Study and Pilot Programme have demonstrated that not only is a design-for-performance approach possible, but also desperately needed. For such an approach to become reality, a scheme would need to be developed, supported by the appropriate governance structures, market demand and industry skills to deliver it.

Figure 5. A diagram highlighting the key elements that would need to be established to deliver a design-for-performance approach in the UK.



SCHEME OWNER & ADMINISTRATOR

A design-for-performance approach would need a central Scheme Administrator to own and operate it. Any scheme in the UK would need to be independent and have effective governance structures in place to ensure credibility and adherence to the NABERS principles that have been key to its success.

Such an administrative body would take responsibility for:

- Publishing the framework for UK Commitment Agreements;
- Developing and managing a well-defined rating tool with accompanying rules and guidance;
- The management of project applications and accreditations;
- The management of the Independent Design Review Panel;
- Overseeing the development and training programmes for assessors and industry professionals; and
- Liaising with the Industry Advisory Board.

INDUSTRY ADVISORY BOARD

An independent committee would need to be established by the Scheme Administrator to provide strategic oversight and input into the governance, success and future direction of the scheme. Participants could include:

- Users of the scheme i.e. property developers and owners;
- Government representatives;
- Industry NGOs; and
- Independent technical experts.

INDEPENDENT DESIGN REVIEW PANEL

A small group of experienced energy efficiency professionals would need to be identified and overseen by the Scheme Administrator. They would need to be selected based on their high levels of expertise in relation to:

- New building projects and the design of HVAC services and their controls;
- Advanced simulation of building performance;
- Commissioning/tuning of buildings; and
- Energy auditing and energy efficiency improvement of buildings.

To support the development of a UK panel, a guide and training materials covering the purpose and intent of the design review will need to be developed.

TRAINING & SKILLS

In order for new projects to implement a design-for-performance approach, practitioners will need to have the appropriate skills and knowledge to deliver the required services to clients. The work of the DfP initiative has highlighted the need for upskilling that would require both informal and formal (accredited) training, including:

- **M&E design engineers:** how to work with simulation consultants to ensure HVAC systems and their controls are appropriately sized and as efficient as possible.
- **Commissioning and fine-tuning consultants:** how to upgrade their existing services in a context where the base building rating is a KPI for building owners.
- **Rating assessors:** creating a cohort of accredited energy rating specialists competent to apply the extensive Scheme Rules to a high standard to ensure the credibility of a rating in the market.
- **Managing agents and facilities managers:** developing a regime whereby building operation and maintenance contracts incorporate base building energy performance-based requirements, and securing the necessary skill sets in the staff involved.

PIONEER PROJECTS

The success of establishing a scheme in the UK will depend on initial projects being put forward by trailblazing property owners and developers, committed to the establishment and long-term success of a scheme. Such projects would be used to test the scheme, demonstrate the business case and stimulate market demand, as well as gaining first mover advantage.

MARKET DRIVERS

Naturally, the success of a scheme would be dependent upon its level of market penetration. A clear communications and marketing strategy would be required that includes:

- Creating a strong, reputable brand that is targeted at a non-technical audience.
- Raising awareness and communicating the benefits to a wide range of real estate industry stakeholders including investors, property owners and developers, occupiers, agents and consultants.
- Liaising with industry bodies to ensure the scheme is referenced within and aligned to other industry initiatives.
- Raising awareness of the scheme within government.

Collaboration with existing voluntary standards and guidelines

Industry collaboration is essential for a design-for-performance approach to be adopted in the UK. The DfP initiative has been working with a wide range of organisations to ensure that the approach is embedded within existing standards and guidance wherever possible and complements these where significant synergies exist. This has included engagement with:

- BCO's 2019 Guide to Office Specification
- BREEAM New Construction 2018
- BSRIA's Soft Landings and Design for Performance Report
- CIBSE's TM39 Building Energy Metering
- RIBA's Plan of Work

The DfP initiative has also engaged with a number of organisations who have been keen to draw on the project's research to help inform energy policy, with the initiative being referenced in the following:

- Government's response to the call for evidence on Helping Businesses to Improve the way they use Energy
- Committee on Climate Change's Reducing UK emissions 2018 Progress Report to Parliament
- Aldersgate Group's Help or Hindrance? Environmental Regulations and Competitiveness
- UK-GBC's Net Zero Buildings - A Framework Definition
- London Energy Transformation Initiative (LETI) Declaration for air-conditioned offices

Next Steps

The DfP initiative has explored whether it would be possible to shift the UK's design-for-compliance approach to one that mirrors the success witnessed in Australia through the NABERS Energy Base Building rating and Commitment Agreement. The Feasibility Study, combined with the Pilot Programme, has found that there are no technical reasons why such a scheme could not operate in the UK.

The key difference between the design approaches witnessed in Australia and the UK is simple. The Australian approach focuses on operational performance outcomes; embedding these in targets, contractual requirements, design tools and independent verification assessments. In comparison, the UK approach sets compliance as its target, with operational performance rarely reviewed.

The next phase for the DfP initiative is to develop the key elements required to implement a design-for-performance approach in the UK. Namely:

- To develop a viable rating scheme with associated rules, tools and assessment and quality assurance processes.
- To identify market pioneers who are willing to develop the approach and commit to setting performance targets for their new development projects.
- To identify training partners who will help upskill the industry in advanced simulation and energy efficient design.
- To work with industry bodies to ensure alignment and synergy with wider initiatives and activities.
- To identify a Scheme Administrator with the responsibility to oversee and administer a scheme in the UK.

With the completion of this stage of the project, it is hoped that it is not the end, but the start of something new for the UK. The approach being recommended is not theoretical or conceptual; it is proven in application. The costs are by far and away outweighed by the benefits. In many ways it is a no-brainer, with only commitment and the desire for change needed across the sector. The Better Buildings Partnership will, therefore, be continuing to work with its members and industry supporters to implement the next phase of work; one that delivers buildings that are designed to perform, and one that delivers, ultimately, better buildings.

1 NABERS Annual Reports www.nabers.gov.au/publications/annual-report

2 http://www.betterbuildingspartnership.co.uk/design-performance-feasibility-study

3 http://www.betterbuildingspartnership.co.uk/design-performance-pilot-programme-technical-report

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