EnergyAction

Commitment Agreements

UK Feasibility Review Report

19 May 2016

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Reference: REP07083-A-001.1a

Quality Control	
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Report Number	REP07083-A-001.1a
Job Number	07083-A
Edition Date	19 May 2016
Print Date	20 November 2015

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1. Executive Summary

This report reviews the operation of the Commitment Agreement in Australia, where the developer of a new building signs up to delivering an agreed level of in-use energy performance, expressed in terms of the NABERS energy star rating, used to benchmark buildings in use[1]. NABERS ratings are available for whole buildings, for "base buildings" (landlord's services), and for tenancies (excluding the base building), but the greatest success of the scheme and of the Commitment Agreement has been for base building performance in leased air-conditioned offices.

NABERS Commitment Agreements have been signed by 147 base building projects since 2002. Of these, approximately 63% of the buildings that have reached the end of the Commitment Agreement have achieved their NABERS target either during or after the Agreement and the balance are still active and within their normal completion timeframe.

The report also discusses the implications for developing a similar scheme for base building energy performance in UK prime office buildings. Its key findings are as follows:

- A Commitment Agreement for base buildings in new offices and major refurbishments has potential to be applied in the UK using the Landlords Energy Rating as the underlying metric, subject to some additional work to resolve the definition of this Rating.
- The Commitment Agreement would be best operated by central government, local government or a suitable NGO.
- The success of the NABERS Commitment Agreement was to some extent built on the success of the NABERS rating more generally: the developers of new buildings were competing with highly rated existing buildings and wanted a process they could follow.
- Whether the UK could use a Commitment Agreement approach to build a successful performance rating culture in existing buildings – i.e. the opposite direction to the pathway taken in Australia – is unknown.
- There is potential to improve upon the Australian process by introducing a more comprehensive structure to the requirements, to ensure that all projects undertake a minimum level of due diligence in undertaking the commitment.
- There is also potential to improve outcomes by providing training to cover the process associated with the Commitment Agreement. Some education around the opportunities and pitfalls of seeking to achieve in-use performance outcomes should also be included.

[1] NABERS energy ratings are expressed on a star scale, with 2.5 stars representing average performance in use when the system was first introduced in 1999. June 2014 data from IPD showed the average office base building rating was 4.2 stars. Today, the mode rating (203 buildings) is 5 stars, 70 have 5.5 stars and 12 have 6 stars, the highest rating and mid-way between 5 stars and net zero carbon, reducing to 60 and 4 respectively without GreenPower. New offices routinely target 4.5 and 5 stars; a few aim for 5.5 and 6 stars.

2. Introduction

This report is a review of the operation of the NABERS Commitment Agreement in Australia in the context of the consideration of a similar process for the UK.

The report is structured around the key research questions for the UK feasibility study. It brings together relevant information and experience from Australia.

It is not the purpose of this report to propose appropriate structures for Commitment Agreements in the UK. However, where relevant, comments are made on how the Australian experience can help the UK to avoid unnecessary repetition of the learning curve.

3. Base building energy use

3.1 Definition of Base Building in Australia

3.1.1 Energy

The definition of “base building” within NABERS was built on the basis of common industry practice for energy metering in Australian office buildings, most specifically in the States of New South Wales and Victoria. The fact that a reasonably common industry definition existed at the time of initiation (1998-99) of the Australian Building Greenhouse Rating scheme (subsequently re-named NABERS Energy) was critical to the scheme’s ability to establish a base building rating. Indeed, when the rating was first developed, no data on *whole* building performance could be located (see overleaf). Since then, NABERS has also done a great deal to create definitions that have firmed up on what had been an informally defined object with significant variation at a detailed level.

The key components of base building energy use are as follows:

- All energy use associated with the general heating, ventilation and air-conditioning system provided to service the office areas of the building
- Light and power to non-lettable spaces (which includes the entry foyer, most lift lobbies, back of house and base-building amenities)
- Lifts (excluding lifts installed within a tenancy by the tenant)
- 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 to)
- Domestic hot water provided centrally and/or to base building amenities. (Local domestic hot water within tenant spaces is not captured with the rating).
- Fuel use for back-up generators

In Victoria and NSW, the common configuration of office buildings is for tenants to be provided with utility-connected electricity meters to cover tenant loads (tenant lighting, floor power and supplementary air-conditioning), while the base building end-uses are separately utility metered. As a result, the building owner has no visibility of tenant energy use. In other States, utility metering tends to be at the whole-building level, with tenants metered by landlord-owned sub-meters; however, the metering boundaries are generally similar. In these situations the landlord has complete visibility of tenant energy use as they on-charge this to the tenants at profit.

When the ABGR/NABERS scheme was first seriously adopted by the market, many buildings spent their first couple of years resolving metering problems, including:

- Non-office loads connected to base building metering
- Allocation of power use in on-floor common areas such as lift lobbies and common area toilets.
- Generally erroneous or dysfunctional metering (especially, but not uniquely, in private metering systems)
- Undocumented metering coverage

It is interesting to note that in addition to resolving problems with measurement and compliance, many of the issues associated with non-office loads also revealed shortcomings in operational efficiency. A common example was base building chiller plant running overnight to serve small non-office or supplementary loads, generally at very poor efficiency.

When NABERS was extended to New Zealand in 2013, the definition of base building was similar but differed marginally in respect of the treatment of on-floor amenities, reflecting different practice in assessment of lettable area. However, roll-out of base building ratings has been much more difficult, because fan coil unit fans and electric heaters (for fan coils and VAV terminals) are often on tenant meters[2]. This is particularly problematic as fan coil units and electric heaters are very common in New Zealand buildings.

Note that while common area light and power is a significant and manageable energy efficiency item, in Australian buildings it typically accounts for only 20-25% of base building energy, while it creates many of the boundary definition problems. Whilst imperfect, a rating based solely on HVAC and or HVAC and lifts would be workable and arguably much easier to measure.

[2] We understand that similar problems were identified in the pilot tests of the Landlord Energy Rating in the UK.

3.1.2 Area

The area used in the NABERS base building rating is measured on the same basis as that used for the other NABERS energy ratings, being the Net Lettable Area (NLA) as defined by the Property Council of Australia's Method of Measurement (1997) document. This measure is broadly similar to the equivalent RICS measure for the UK.

Roughly speaking, the Australian NLA definition includes all of the areas in the building available for tenants to occupy for office uses, excluding:

- Entry foyer
- Lift lobbies where lifts face to a blank wall or another lift bank
- Lift shafts
- Services risers
- Plant rooms
- Fire Stairs
- Common area amenities (typically a sink/hot water kitchenette, toilets, and cleaners' cupboards)

3.1.3 Hours

Under NABERS Rules, hours for base building ratings are calculated based on a combination of core hours and after-hours. Core hours relate to hours for which comfortable conditions are required – i.e. not including start up periods. After hours are typically evaluated based on logged tenant requests. For the majority of buildings, the impact of after-hours air-conditioning on the NABERS hours figure is minimal – 1-2 hours per week on top of a 55 hours per week core service period[3].

[3] Energy use in after-hours periods varies strongly, depending on whether they occur as a run-on from normal hours (where costs are minimal) or as an isolated hour on a weekend in a centrally serviced building, in which case energy use intensity on a time/area basis can be up to 8 times that of normal operation.

3.1.4 Indoor Environment Quality

Nearly all Australian office buildings are provided with heating, ventilation and air-conditioning and do not have opening windows. As a result, there is an expectation of reasonably consistent control all year round. The most common control band is 22.5°C±1.5°C, which is generally accepted as an unwritten requirement, but sometimes expressly included in lease documents. Humidity is not actively controlled in office buildings unless the building technology demands it (e.g. chilled beams) or the building has specifically aimed to achieve humidity control credits within the GreenStar rating system. Tenants rarely request active humidity control and it is not a market expectation.

NABERS does not test for quality of air-conditioning, which is a requirement under some other schemes such as Energy Star. However, NABERS adopts the position that the quality of air-conditioning is regulated by the market, a position which is largely possible because of the undifferentiated nature of the building stock. With the UK's mix of fully-conditioned, mixed-mode and heating-only buildings, this assertion becomes more open to challenge, raising the possibility that base building ratings should be supported by an Indoor Environment rating of some kind.

Ventilation rates for code compliance are defined under *AS1668: The Use of Ventilation and Airconditioning in Buildings*, and are set at 7.5 l/s per person for systems with high efficiency filtration and 10 l/s per person otherwise. These figures are marginally lower than those recommended in the BCO Guide for Specification.

Lighting within tenancies is determined under AS1680: Interior and Workplace Lighting. Tenants expect that a vacant office will be provided with lighting that is capable of providing 320 lux maintained average illuminance with minimal fitout; in practice, tenants often add additional lights to compensate for shading from fitout partitions. Note that the 320 lux requirement reflects "general office tasks"; intensive computer screen work such as call centres are only required to achieve 240 lux. These figures contrast with the latest CIBSE Guide LG7 (2015) which recommends 500 lux for paper based office work and 300 lux for screen based tasks[4]. These figures would be considered poor practice in Australia[5].

3.1.5 Supplementary air-conditioning

The treatment of supplementary air-conditioning is an area where NABERS has tended to drive change in industry practice rather than just following it. An indirect result has been that the NABERS Rules around supplementary air-conditioning have been subject to some movement and re-interpretation over the past decade and may change again in the next edition. However, the general principles remain fairly consistent, as follows:

[4] These figures are also cited in the BCO Guide to Specification

[5] In "Lighting in Call Centres", E. Kenna and P. Bannister, Building Performance Congress, Frankfurt, April 2006 it was identified that light levels above 200 lux were potentially a cause of visual discomfort for call centre operators

1. A tenant-installed air-conditioner in an enclosed space such as a meeting room or a computer room is almost always considered to be supplementary and thus falls outside the scope of the base building rating.

2. A tenant-installed air-conditioner in an open plan space is ambiguous and may be treated as either base building or tenant depending on circumstance.

3. An external service provided to tenant supplementary systems (e.g. condenser water, chilled water or hot water) is considered to be a base building service if it is generally available to the majority of the building and/or to more than one tenant.

On-floor supplementary air-conditioning units rarely make a fundamental difference to the NABERS rating awarded; by contrast a poorly managed supplementary condenser water loop can be a half-star penalty on building performance and an overnight supply of chilled water from base building chiller plant to tenant supplementary fan coils worse than that.

Management of the landlord-tenant boundaries remains important because, in the extreme case, excessive supplementary air-conditioning can supplant base-building air-conditioning loads almost completely, creating a false impression of efficiency.

3.2 Tenant impacts on Base Building energy use

In most Australian climates, office buildings are nominally cooling dominated; this means that increased tenant loads will increase base building energy use. However two studies by Energy Action on behalf of the NABERS administrator have demonstrated that the scale of this impact on the base building rating is minor, with typically less than 0.3 stars between an “average” and an “extreme” tenant, using four times as much electricity. In cooler climates, the impact on base building energy use decreases because internal gains from tenants displace heating energy.

Base building energy use can therefore be considered to be first-order independent of tenant behaviour (apart from the influence of operating hours, which are accounted for when calculating the rating). This has been a key factor in the acceptability of base building ratings to building owners. In spite of this, some consultants and developers have sought to make a minimum tenancy NABERS rating a prerequisite of accepting liability for a base building rating. However, this is not a particularly well framed or effective risk management approach: in practice, the major influence of tenants on base building energy use lies not in tenant loads, but in more subtle interactions between landlord and tenant over service expectations, the provision of services to supplementary air-conditioning, and the management of operating hours.

3.3 Base building energy use – quantification

3.3.1 Total Base Building energy use

The NABERS scale is based on greenhouse gas emissions rather than energy, and so the range of energy use associated with a rating will depend on the fuel mix. The table below identifies base building energy use for all-electric and 80% electric/20% gas buildings in Brisbane, Sydney, Perth, Melbourne and Canberra at 2.5 stars (nominal market average) and 5 stars.

Location	2.5 stars, all electric (kWh/m^2 delivered)	2.5 stars 80% electric 20% gas (kWh/m^2 delivered/ LER kWh(e) Elec equivalent[6])	5 stars, all electric (kWh/m^2)	5 stars, 80% electric 20% gas (kWh/m^2 delivered/ LER kWh(e) Elec equivalent)
Brisbane	157	186/163	100	119/105
Sydney	183	215/190	86.4	102/89.6
Perth	144	169/149	75.8	89.6/78.8
Melbourne	147	177/156	52.7	63.4/55.8
Canberra	150	177/156	53.7	63.3/55.7
LER comparison	135	135	60	60

Note that although 2.5 stars was notionally market average when the scale was set in 1999, subsequent improvements in performance, especially in the upper end of the market, have pushed the average up by at least 1 star. IPD data shows the area-weighted average had reached 4.2 stars by June 2014[7].

The apparent inconsistencies in the energy intensity at 2.5 stars, particularly for Sydney reflect the fact that the scales were reset on a state-by-state basis as the scheme was rolled out to a particular State, not always on the basis of consistent data. The 5 star level, which was based on simulation, shows more consistent behaviour.

In August 2011, NABERS extended the top of their scale to 6 stars, stating 5 stars represented excellent performance, and 6 stars market leading[8]. The new 6 star level was set by taking a theoretical 7 star level as zero emissions and applying a 50% reduction in the emissions at 5 stars. Similarly, 5.5 stars is a 25% reduction from the 5 star level.

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[6] Electricity equivalent kWh(e) is a simple but useful metric used by the Landlord's Energy Rating to put different sources of energy on a common basis. It multiplies kWh of fuel burnt (most frequently gas) by 0.4 and kWh of hot or chilled water delivered from community heating and cooling systems by 0.5 and adds them to the kWh of electricity.

[7] http://www.cbd.gov.au/files/files/Exploring%20movements%20in%20the%20NABERS%20Energy%20ratings%20of%20offices.pdf

[8] http://www.nabers.gov.au/public/WebPages/DocumentHandler.ashx?docType=3&id=11&attId=0

3.3.2 Typical Base Building energy end use breakdowns

Figures 1, 2 and 3 below represent typical base building energy end-use breakdowns taken from well metered buildings rating in the region of 4.5 stars in Sydney; 5 stars in Sydney and 4 stars in Melbourne. The electricity equivalents of these base buildings are 106, 89 and 95 kWh(e)/m^2 respectively.

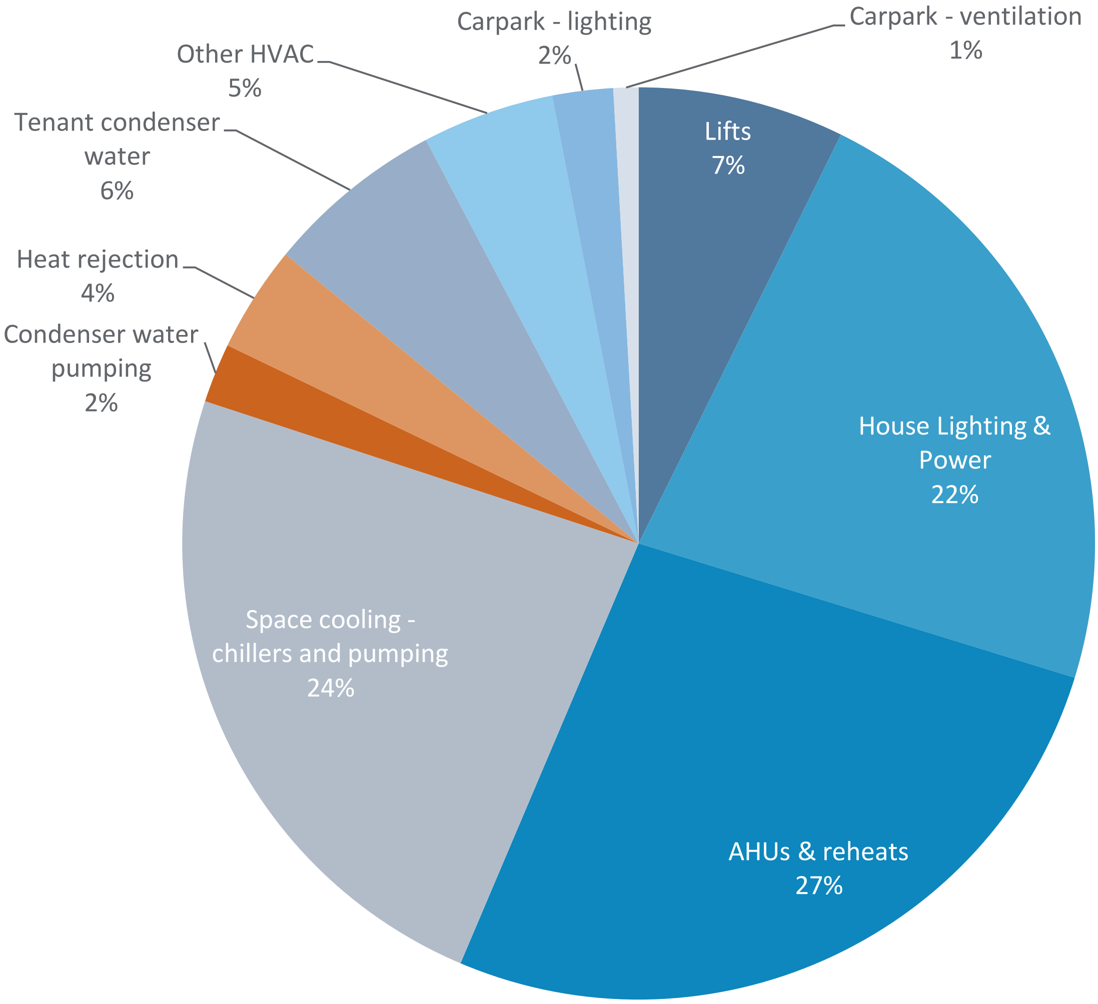

Figure 1. Base Building Electricity End Use Breakdown for a refurbished VAV building in Sydney running at approximately 4.5 stars. Gas consumption for this building represents a further 2% in addition to this, covering preheating of minimum fresh air supply only. Total electrical energy use is approximately 105 kWh/m^2; Gas use is approximately 2 kWh/m^2

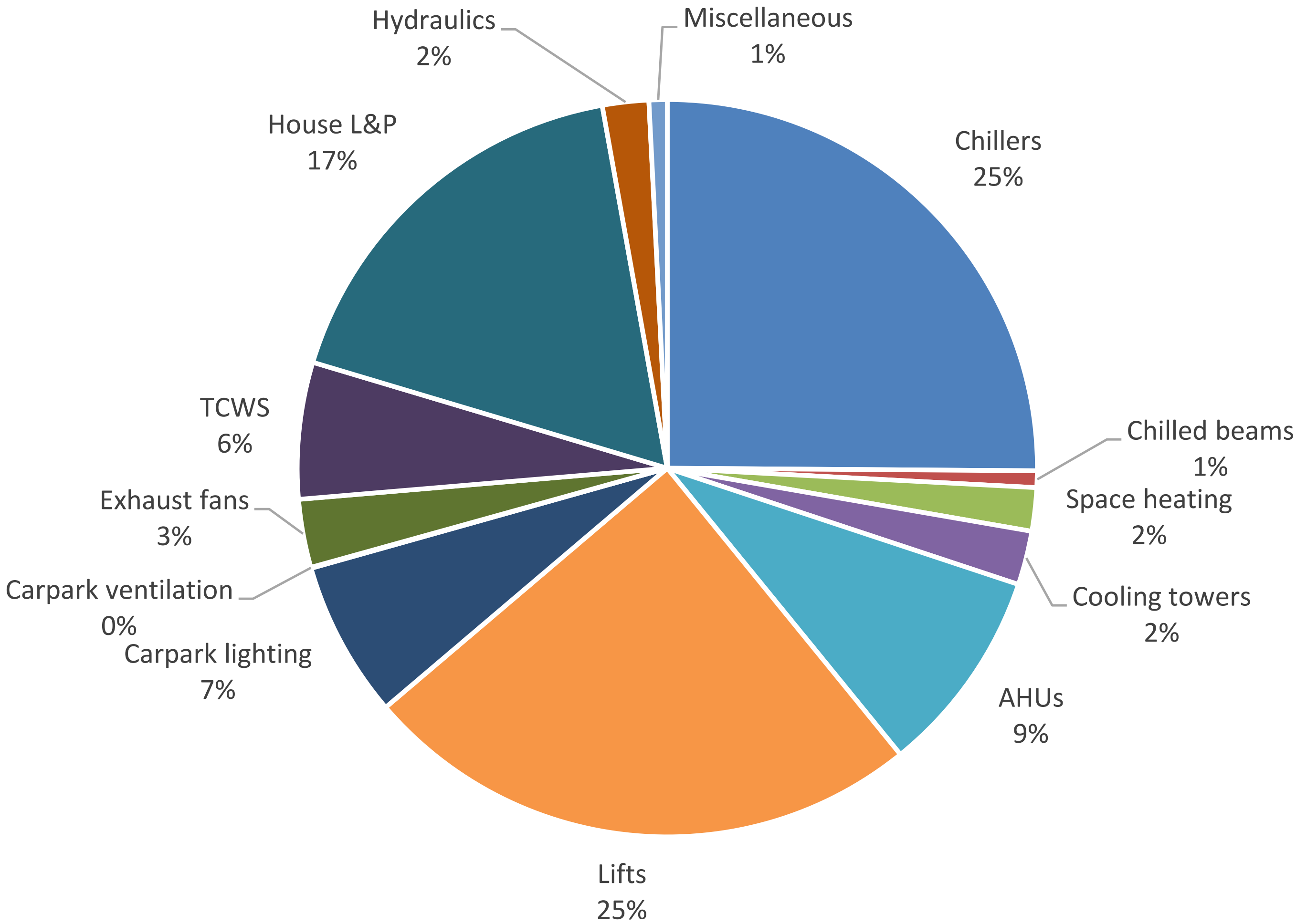

Figure 2. Electricity end-use breakdown for a 5 star hybrid passive chilled beam/VAV base building in Sydney. Total electricity consumption is 72kWh/m^2. Gas use for this building, which covers space heating, reheat and most domestic hot water, comprises a further 43kWh/m^2.

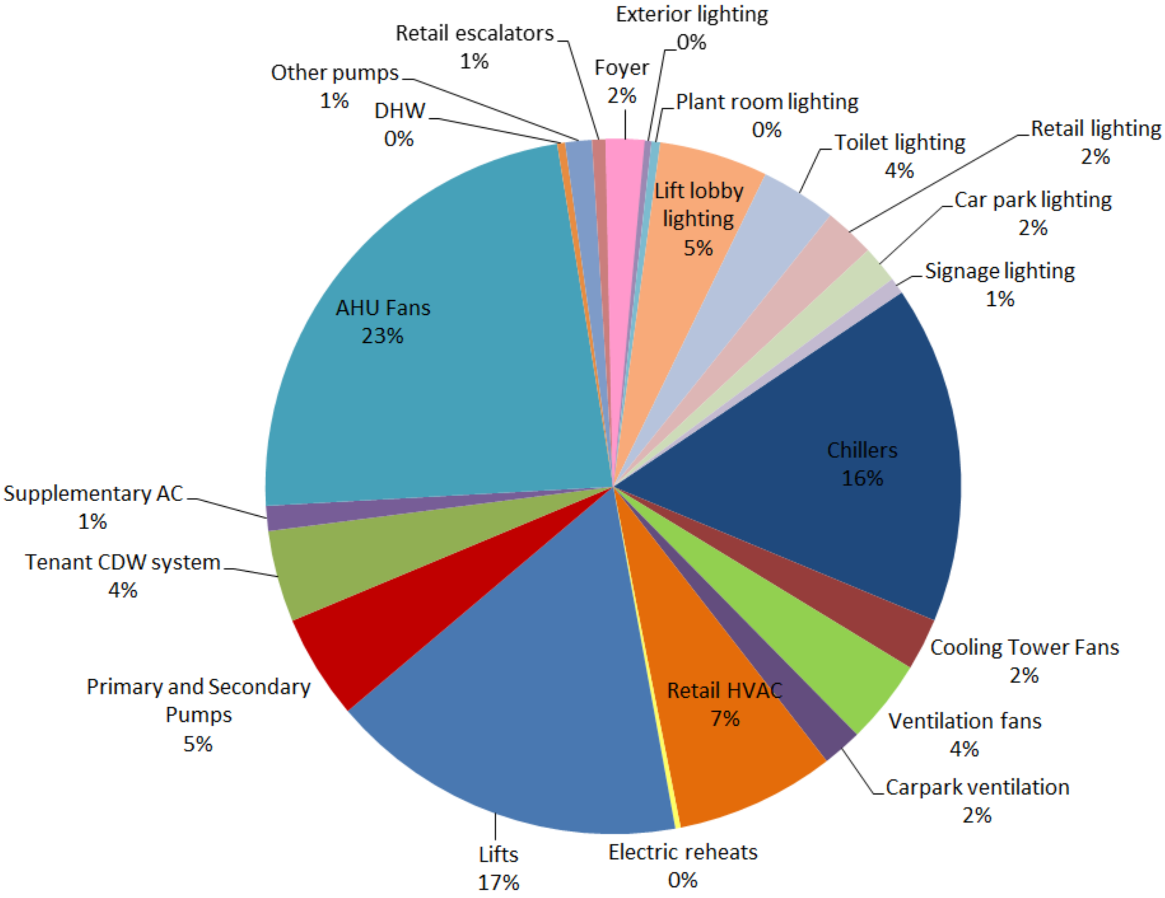

Figure 3. Energy end-use breakdown for a 4 star NABERS VAV building in Melbourne. Total electricity consumption is 88kWh/m². Gas consumption at the site (for space heating) is a further 18kWh/m².

As the figures above illustrate, there are substantial variations in end-use breakdown between individual buildings, making it difficult to conclusively identify any particular patterns of change as the NABERS rating deteriorates. Anecdotally, the broad distribution between HVAC and other uses is similar at around 70:30 across most buildings irrespective of rating. Gas consumption is often quite high in lower-rated Australian office buildings, as poor control of heating systems is widespread.

3.3.3 Climate context

It should be noted that the UK and Australian climates have essentially zero overlap, as demonstrated in Figure 4. Thus the end-use breakdowns presented in the previous section should not be expected to be replicated in UK buildings.

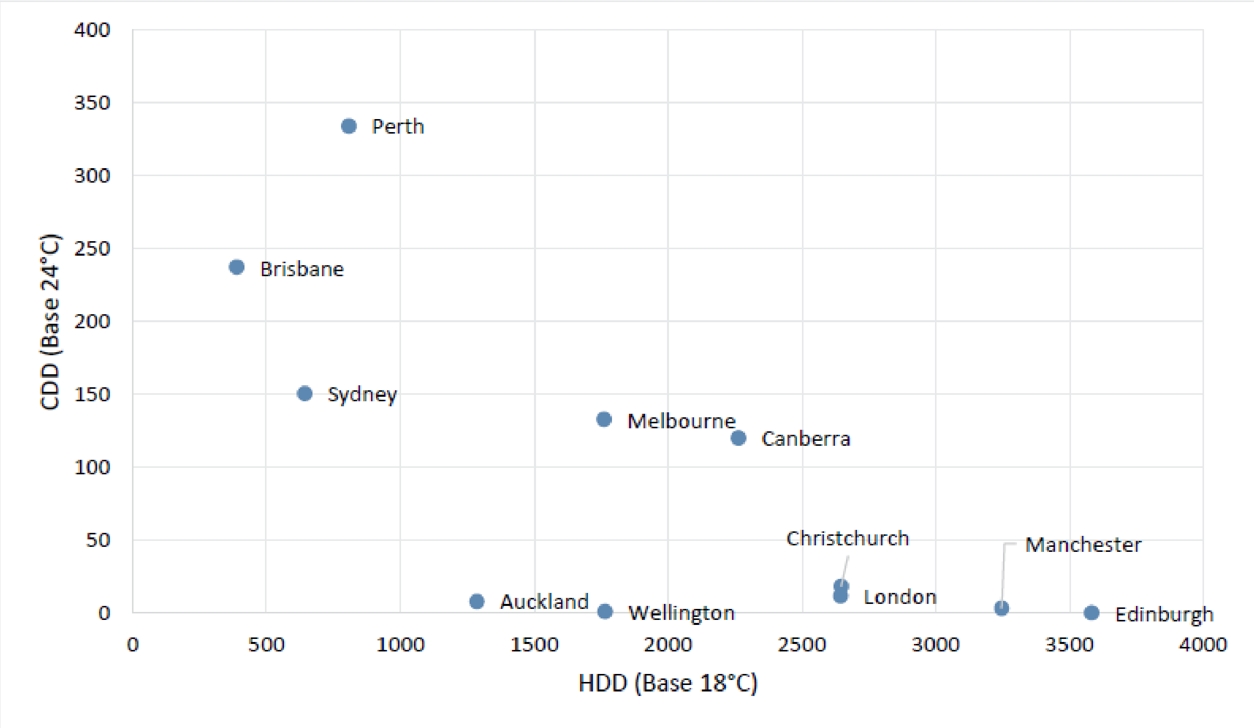

Figure 4. Climate comparison for Australia, New Zealand and the UK. It can be seen that there is no overlap between Australia and New Zealand, and only marginal overlap between New Zealand and the UK. Note also that the Cooling Degree Day (CDD) scale is based on dry bulb, as this is readily available data; wet-bulb is a better indicator of cooling requirement and would change the relative positions of Brisbane and Perth, and significantly increase the differentiation between Canberra, Melbourne and Sydney.

3.4 The Landlords Energy Rating in the UK

The Landlords Energy Rating (LER) was developed as a scheme for the UK by Verco on behalf of the Better Buildings Partnership. The structure of the LER is very similar to the NABERS Base Building rating, with a few exceptions:

1. As befits a prototype scheme, the rules are largely undeveloped.
2. No specific protocol for the measurement of floor area is identified, though the RICS definition of NLA is implied
3. Adjustments for heating degree days and hours are based on the adjustments for the DEC (Display Energy Certificate) benchmark, the basis of which is not known to this reviewer
4. Adjustments for cooling degree days are based on a separately derived equation based on the energy needed to cool outside air intake.

5. Energy values are modified by factors of 1.0 for electricity, 0.4 for fuels and 0.5 for thermal energy. The sum of these is called the "electricity equivalent" (see Section 3.3.1). The conversion factors reflect primary energy in a simple manner; the choice here of metric is of course a policy rather than technical matter[9]: NABERS uses greenhouse gas coefficients.

6. The mechanism for adjustment for vacant space is computationally different from that of NABERS, as NABERS calculates the hours for the occupied spaces while LER calculates an average hours over all spaces[10].

7. The minimum energy coverage differs from NABERS in some aspects, particularly around centrally supplied auxiliary services such as tenant supplementary air-conditioning condenser water (which of course may not be a common provision in the UK, but is in Australia). The treatment of tenant supplementary air-conditioning is slightly different from NABERS in that under NABERS tenant air-conditioning to meeting rooms is excluded from the base building rating.

8. It is not clear that casual after-hours air-conditioning is accounted for in the LER

9. A wide range of calculation methods are provided to deal with issues of metering and coverage, reflecting the known measurement and boundary issues in the UK market.

The overall basis of the LER is a reasonable starting point for use in a Commitment Agreement, with the following caveats and suggestions:

1. As the scale uses the DEC as a 3.5 star evaluation point, the floor area, hours and energy derivations may need to be coordinated with the DEC methodology

2. The basis of the cooling degree day adjustment is questionable and should be tested by simulation. The correlation between heating and cooling degree days for locations around the UK may be sufficient for only one of these variables to require correction.

3. Treatment of tenant supplementary air-conditioning requires review to ensure that this balances the need to avoid encouragement of under-servicing of base loads with the competing requirements of measurability and fairness in association with the servicing of exceptional loads such as tenant computer rooms.

[9] An approach based on common international weighting factors would facilitate comparisons of building energy performance in different countries, specifically between the UK and Australia; however this may be at the risk of losing local relevance.

[10] The relative merits of these approaches is open to debate and depends largely upon the details of implementation. As author of the NABERS approach, the author of this report prefers the NABERS approach because it enables correction factors for hours and area to be independently derived but the differences are probably minor in all but the most extreme cases.

4. The detail of rules needs to be developed across all areas to reduce the opportunities for uncertainty or gaming.

5. Calculation methods should be avoided in relation to the Commitment Agreement[11]. Instead, part of the building design and review process should be to ensure that metering can accurately measure the rating; for metering deficiencies beyond this, a less generous and more punitive approach should be adopted, similar to that used by NABERS.

3.5 Lessons learnt in Australia re Base Building energy use

3.5.1 Base building ratings are critical

The separability of base building energy use has been critical to the success of the NABERS energy rating system, and of the NABERS Commitment Agreement. This is because base building energy use is first-order independent of tenants, so can be reasonably managed to a target irrespective of tenant. The adoption of a suitable model for base building energy use is therefore critical.

At its most basic, it is arguable that a base building energy use for assessment in a Commitment Agreement could be confined to HVAC only, or HVAC and the lifts, provided suitable rules are made around supplementary air-conditioning. It is highly desirable to include common area lighting, but not essential.

Treatment of car park energy has been a source of some issues with the NABERS rating and is not essential to the formulation of a Commitment Agreement for the UK. If included, consideration should be given to the use of a specific car-park adjustment in the rating benchmark similar to that used in NABERS for Shopping Centres, as the current NABERS methodology in this area is open to gaming.

It is essential that the rules around whatever boundaries are used are well defined and do not encourage gaming by designers. Experience in Australia has shown that when some design teams seek to improve NABERS performance, creative accounting may be the first, not the last resort.

3.5.2 The role of Whole Building and Tenancy ratings

However, there are limitations to the base building rating. In particular, it is predicated on the assumption that the building is developed with the classic owner/tenant split, with the owner operating the building as a vessel for multiple tenants, who may change regularly. This assumption is reasonable for a large portion of the market in Australia, but does not work so well for the small group of buildings that are either owner-occupied or are leased on a long term basis to a single tenant, for example a bank or a government department.

[11] And indeed in the LER more generally

In these situations, the base building boundary is not always rational. For example, for a major bank headquarters in Sydney, the requirement for a high NABERS base building rating created significant pressure for separate servicing of the bank's data centre and the base building, risking significant additional project expense and/or a poorer efficiency outcome. It would have been assessed more rationally as a whole building not a base building.

In the UK, the use of both Base Building and Whole Building Commitment Agreements should not be ruled out, depending on the extent to which the market is balanced between these different types. While it is probable that the majority of buildings are better assessed as base buildings, as a global city, London may contain more buildings that would be more appropriately assessed as whole buildings.

Tenancy ratings speak to a completely different segment of the market and can be considered largely in isolation from the Base Building Commitment Agreement; given the significant energy use of tenants in the sector as a whole, there is a reasonable case for the use of a Tenancy Commitment Agreement, although the significant barriers to energy efficiency activity among tenants (see Section 4.5.2) will tend to limit the number of Agreements.

4. Application of the Commitment Agreement in Australia

4.1 Commitment Agreement requirements and philosophy

The NABERS Commitment Agreement essentially comprises the following three requirements:

1. A simulation to demonstrate that the building is theoretically capable of achieving the proposed rating.

2. An independent design review to examine the simulation results, judge whether or not they are likely to be plausible, and identify risks, issues and opportunities related to the likely performance of the proposed design when it comes into use.

3. A post-construction NABERS rating to validate the achieved post-construction performance.

With the exception of the post-construction NABERS rating, the emphasis of the above process is not to establish pass/fail against some standard, but to ensure that the design team have some understanding of the risks of non-performance associated with their design and are given the opportunity to make changes, if they see fit.

The NABERS team rarely if ever cancels a Commitment Agreement on the basis of the simulation or review; this is partly because the theoretical performance of most new buildings today can usually reach 5 stars or better, and partly because the NABERS team does not have the resources to engage in a technical discussion on the merits or otherwise of either the design or the review.

It would be fair to say that only the most damning independent design review would prompt a response from the NABERS team questioning the viability of the Commitment Agreement. In practice, in order to avoid this predicament, a poor review will be renegotiated between reviewer and design team before submission to NABERS; usually involving changes to design, rectification of simulation analyses and occasionally some rewording of over-zealous criticism by the reviewer.

In practice, the NABERS Commitment Agreement requirements fall far short of the full process required to be sure of delivering a building that will achieve a high performance target; however they are intentionally designed not to create a massive administrative burden. It is considered the responsibility of the project team either to innovate to achieve the outcomes required – or to fail and learn some painful lessons along the way. This light-handed approach also avoids the situation where the independent design reviewer or the NABERS team becomes responsible for the performance of the design, and all the associated legal complications and costs.

4.2 Simulation

4.2.1 Use of simulation in Commitment Agreements

Simulation is used in the NABERS Commitment Agreement to demonstrate that the building has the theoretical capability to achieve the targeted NABERS rating. Simulations are not required for Commitment Agreements at 4 stars, as this was considered to be "normal practice" and achievable without special effort at the time the Commitment Agreement was formulated[12]; however all Commitment Agreements targeting higher than this require a simulation.

Simulations for the NABERS Commitment Agreement need to comply with the NABERS Guide to Building Energy Estimation[13]: checking compliance with this is part of the Independent Design Review discussed in Section 4.4.

The NABERS Guide to Building Energy Estimation serves two functions, being:

1. To assist simulators in producing a simulation that provides a realistic and complete estimate of post-construction consumption.

2. How to translate the simulated energy use into an estimated NABERS rating.

The first of these functions is significant, in that historically simulation has largely been seen as a comparative tool for scenario analysis, not a means of prediction of absolute performance. Key components of the Guide include:

- Recommended default schedules for tenant loads and occupancy to be used if tenants are not known; if tenants are known, the Guide requires the simulator to base their load and occupancy estimates on information directly relating to these tenants, as far as possible.
- The scope of energy coverage, including a list of non-simulated items such as energy associated with emergency generator testing, for which estimates should be made;
- Requirements to calculate and report estimated NABERS Ratings based on the simulation in the same way that the energy will be metered in the actual building, allowing metering non-compliance to be detected in the simulated results and outcomes at component level to be measured and verified.
- Requirements for "off-axis scenarios" testing the robustness of the base case prediction to failures in operation and errors in assumptions in the model, both individually and in combination.
- Minimum reporting requirements to enable third-party review.

[12] As the market has advanced, no-one does Commitment Agreements for 4 stars any more as this is no longer seen as a desirable rating to maintain, let alone target; 4.5 stars is seen as entry-level now.
[13] Available from www.nabers.gov.au under "Resources"

Compliance with these specific requirements has improved markedly over the time the Commitment Agreement has been in force. Key areas of ongoing weakness include:

- Controls representation and reporting. This is probably the weakest area in simulations generally, partly because controls representation in simulation packages are incomplete to a greater or lesser extent, but mainly because few simulators have in-depth understanding of controls. In general, this results in sub-optimal controls being used, with accordingly pessimistic simulation outcomes.

- Fan and pump representation. When compared to post-construction results, fan energy tends to be over-predicted due to overly conservative estimates of the rate at which power turns down relative to flow. By contrast, pump energy estimates tend to be much less than practically achievable levels in most buildings, owing to the greater practical constraints of pump selection and the effects of "low delta-T syndrome"[14].

- Off-axis scenarios. The lack of controls knowledge of most simulators means that their ability to set realistic off-axis scenarios is limited. Furthermore, where simulators are part of the design team, they tend to want to use the off-axis scenarios to validate rather than challenge the design. As a result the off-axis scenarios are often very "soft" and do not really test robustness effectively.

- Representation of more complex problems. An increasing number of Australian buildings use cogeneration or trigeneration. The ability of both simulators and simulation packages to represent these is generally poor. In addition, complex ancillary systems such as black water treatment plant often come with little information on expected energy use.

- Assumptions. While the intent of the Guide is to produce "realistic" estimates, it is common for simulators (especially where they are part of the design team) to make conservative assumptions, as protection against the risk of predicting a higher than achievable efficiency. Such assumptions are not always declared or obvious. While this may seem prudent, it can lead to over-capitalisation of the design, for example adding a trigeneration system to a building that was capable of achieving the required rating without the additional expenditure. This does not please clients, who ultimately have to pay for the conservatism of the simulator and the associated design team[15].

[14] See "A Beginner's Guide to Better Simulations" P Bannister Ecolibrium May 2014 Australian Institute of Refrigeration, Air-Conditioning and Heating Inc

[15] Excessive conservatism in design is an issue in itself, and can generally be limited by careful prescription of performance requirements within the design brief and specification.

In spite of this, there is now good evidence that simulation and post-construction results are capable of aligning sufficiently well to validate the basic approach of using simulation as an absolute performance predictor[16].

With the convergence of well formulated simulations and well-metered buildings, it is now possible to provide post-construction performance targets at subsystem level[17]. Not only has this proved to be a successful tool for first-year monitoring, it also provides feedback on the strengths and weaknesses of the simulation, which frequently gets total consumption about right but is less reliable at sub-system level. In practice, all building projects will move from simulated targets to historically-derived targets once the first year of monitoring is complete.

4.2.2 Use of simulation in design

The NABERS Guide also provides guidance on how simulation should be used throughout the design process as a means of guiding and testing the design as it develops. Unfortunately, this seems only to occur in a minority of cases. Most building projects seem to use simulation purely as a compliance tool, which means separate simulations for:

- NABERS Commitment Agreement
- Green Star ENE-1 and ENE-2 credits (and IEQ-9 credit for offices, which covers PMV calculations)
- Building Code of Australia compliance calculation, where the performance method is used rather than deemed-to-satisfy.

Since first mooted in 2011, efforts to coordinate requirements between these different systems have not progressed greatly, owing to a lack of government support. In addition, while GreenStar and the Building Code are essentially seeking theoretical tests only, and have sufficient commonalities that alignment is feasible, the NABERS Commitment Agreement has significantly different requirements, which can at best be only partially aligned with the other systems.

Most simulation work in Australia is undertaken by the project mechanical services consultants. Given a normal silo approach to design, this means that the building façade is seldom questioned, thereby losing the largest opportunity for the use of simulation in design optimisation. Mechanical services design decisions are generally made by rule of thumb and very few design consultancies use energy simulation to size plant – they will instead use a separate sizing program. Typically the simulation trails rather than leads the design and as a result is not able to inform strategic decisions.

[16] See "Modelling as an Accurate Indicator of Exemplary Building Performance" P Taylor, H Zhang, P Bannister Proceedings of the International Building Performance Simulation Association Conference (Building Simulation 2013), Chambery, France 2013

[17] See "The Application of Simulation in the Prediction and Achievement of Absolute Energy Performance" P. Bannister, Proceedings of the International Building Performance Simulation Association Conference (Building Simulation 2009), Glasgow July 2009.

In spite of all this, it is notable that the industry has become able to deliver significantly more efficient buildings. Over the next few years, it is also possible that smarter use of simulation will become a differentiating factor for better buildings, as there is anecdotal evidence that 5.5 star buildings can be identified by significantly better façade design than 4.5 and 5 star buildings.

4.3 Simulation packages

The NABERS Commitment Agreement leaves consideration of the suitability of the simulation package to the design team in the context of the simulation requirements of the building. In practice, the packages used are common BESTEST accredited commercial packages, in particular:

- IES Virtual Environment
- Energy Plus, typically via an interface such as Design Builder
- TAS
- Beaver

Of these only Beaver is a purely Australian package; this model is very widely used by design consultants and is of an older generation of simulation design (being functionally similar to DOE-2). Although arguably inferior, there is little evidence that its predictions have been significantly less reliable than those from the newer packages.

Simulation packages operate with a variety of different levels of BIM compatibility. However, at the present time, there is little evidence that much use is made of BIM in simulation models used for NABERS Commitment Agreements, or indeed for any other purposes.

4.3.1 Simulation skills and accreditation

No accreditation is required to undertake a simulation for a NABERS Commitment Agreement. When the Commitment Agreement was started, the necessary skills were not well enough understood to define a suitable accreditation standard. Today, there continues to be little in the way of successful accreditation systems for any other uses of simulation, so it is not recommended that the UK considers developing accreditations for Commitment Agreement modellers.

It is notable that the skills required for a Commitment Agreement simulation are broadly the same as those used in simulation for code compliance: however, the former requires an attempt at “reality” in simulation whereas the latter operates within a limited theoretical framework that is not intended to mimic reality.

In practice, the skill of the industry in undertaking simulation has improved immensely over the duration of the NABERS Commitment Agreement. While the NABERS Guide for Building Energy Estimation has hardly changed over this period, the compliance and completeness of simulations produced in response have improved remarkably. The NABERS Independent Design Review critiques of simulation have definitely played a role in this, though in the past decade there has also been a dramatic increase in the use of simulation for code compliance and GreenStar which have also driven increased quality of simulation work.

4.3.2 Applicability of the NABERS Simulation Protocol to UK

The NABERS Guide to Building Energy Estimation was first written more than 10 years ago and has survived with few changes in that period. Adaption to the UK should be relatively simple, with the following caveats:

1. Much of the Guide is dedicated to providing information about the NABERS rating and how energy is accounted under the NABERS base building rating; this would clearly need adaption to suit the agreed boundaries of energy coverage and area calculation for the UK Commitment Agreement.

2. Owing to the greater diversity of building servicing, it may be necessary to provide more guidelines on the assessment of thermal comfort (an Indoor Environment rating of some kind), in order to ensure that buildings do not predict optimistic energy efficiency outcomes as a result of poor simulated service provision.

3. The Guide itself is significantly out of date and trails current best practice. Recent work by the author has attempted to address this[18], but a significant update of the Guide could deliver better results and education to the simulation community. It is recommended that **a UK Simulation Guide would build on the NABERS Guide to incorporate far more of this additional knowledge**.

4.3.3 Capacity building for simulation

The NABERS Guide has led to a significant improvement in simulation skills in the Australian industry over the past decade. There is significant potential for the benefits to be realised with greater speed and efficiency in the UK. In particular:

[18] "A Beginner's Guide to Better Simulation" Ecolibrium, May 2014, Australian Institute of Refrigeration, Air-conditioning and Heating

1. The Guide itself should provide, or be accompanied by, significantly more technical information of the estimation of energy use for non-simulated loads (lifts, miscellaneous power use and common area lighting in particular) and key simulated loads (fans, pumps as well as proper representation of chillers, boilers and the associated circulation systems)[19].

2. The material in the guide and supporting information should be embodied in a course. **It could be argued that satisfactory completion of a course of this kind should be a pre-requisite of being permitted to undertake simulation for the UK Commitment Agreement**[20].

4.4 Design review process

The second component of the Commitment Agreement is a NABERS Independent Energy Efficiency Design Review by a member of the associated NABERS Independent Energy Efficiency Design Review Panel. Its purpose is to provide independent peer review of the ability of the building to achieve the target performance, from a number of different perspectives:

1. Simulation: Is the simulation a reasonable and complete representation of the building's potential post-construction performance, following the requirements of the NABERS Guide to Building Energy Estimation? What is the reviewer's assessment of the predicted NABERS rating and their interpretation of the likelihood that this will be achieved in practice?

2. What are the risks in the building design? These may include:

    a. Design risks, such as ambiguities or incompleteness in documentation;
    b. Technical risks, such as the use of technologies or approaches with high failure rates and/or high consequences of failure in practice; and
    c. Process risks, such as poor commissioning specifications or lack of a post-construction monitoring and verification programme.

3. What are the opportunities for better design? These may include:

    a. Risk management opportunities, such as changes in process etc to address the risks identified above, or changes to design to avoid these risks; and

    b. Technical opportunities, such as changes to the design to improve performance both at system level (e.g. changes to AHU layout or overall HVAC philosophy) and component level (e.g. more efficient chillers, boilers, motors, etc)

[19] There is potential here for revisions and/or supplements to CIBSE Technical Memorandum TM 54: Evaluating operational energy performance of buildings at the design stage.
[20] It can be assumed that those undertaking simulation for the UK Commitment Agreement would in any case be accredited to EPC Level 5, thereby demonstrating competence in the use of Dynamic Simulation Modelling (DSM) software.

The design review ideally occurs at around the 30-60% design completion stage, by which time there is sufficient documentation to enable a comprehensive review while still leaving some capacity for changes to design. In practice, many design teams will leave the design review until significantly later in the design (90%+ completion) and sometimes well into the construction phase. Occasionally, the design review is conducted prior to the availability of a simulation, but the report is always finalised with consideration of the simulation results

The design review is NOT a compliance review: the design team is free to ignore as much of the advice of the reviewer as they like. Alternatively, the team may choose to make some changes to their designs or processes whilst ignoring others, in which case, where performance issues do arise post-construction, they could argue that they took the advice on board to the extent possible. As the design review is very much a menu of suggestions, it is never the case nor the expectation that its recommendations will be wholly adopted. In essence, the design review is best regarded as an input in the design team's risk management in relation to achievement of the target rating.

A typical design review produced by Energy Action is over 30 pages long, with a fee of $A10,000-$A12,000, while a review for a small simple building is typically 20-25 pages long and $A6,000. A reasonably large amount of text is repeated from review to review, because many risks and opportunities are common from project to project. The cost of a design review tends to vary with floor area and building complexity rather than the target rating; the reality (for Energy Action reviewers at least) is that the building will get a thorough review, irrespective of the target rating.

The author cannot shed a great deal of light on reviews conducted by design reviewers outside Energy Action, other than to note that the emphasis changes between reviewers; specifically Energy Action reviews tend to be heavily focused on design, whereas some other reviewers focus more on the simulation than the design. No evidence is available as to whether any design reviewer achieves better or worse results than others in terms of the success of the project post-construction.

4.4.1 Qualifications of the Design Review Panel

When Commitment Agreements started in 2002, the reviews were undertaken by the originators of NABERS Energy. As the scheme gained momentum in 2004, a panel was selected via a competitive process. Eight reviewers qualified. To do so, each reviewer had to produce a sample review of a real building design which was then assessed by independent experts[21]. Each reviewer was selected on the basis of their ability to demonstrate the following:

- A knowledge of new building construction.
- A knowledge of energy auditing and the energy efficiency opportunities in operating buildings.
- Their ability to produce a design review report meeting the intent of the Independent Energy Efficiency Design Review.

[21] Including Bill Bordass

Of the original eight reviewers, three basically never went on to produce a review for a client and one dropped out of the profession, leaving four active reviewers (including two within Energy Action). In 2015 the panel was competitively re-tendered and increased to ten reviewers (including three from Energy Action).

4.4.2 Operation of the Design Review Panel

The design review panel has been largely self-sustaining. Although administered by the NABERS administrator, this has required very little input beyond its original establishment and subsequent re-tendering. The limited administration requirement is driven by the fact that the design review is an advisory rather than a compliance process.

Two constraints are applied to design reviewers, being:

1. They must be independent of the design team, i.e. free to make recommendations for changes to the design without worrying about how the related costs might affect their own company. Note that this does not stop the design reviewer from being the simulator; indeed, design reviewers tend to do better simulations because they use them to query and test the design, rather than to validate it.

2. The design reviewer's company is not permitted to undertake the post-construction NABERS rating used for compliance with the Commitment Agreement. Note that this is the only conflict of interest situation that is enforced to prohibit an assessor undertaking a NABERS rating; in all other cases declaration of the conflict is sufficient to permit the rating to proceed using the conflicted assessor.

In practice, design reviewers frequently take a larger environmental/sustainability design advice role with the design team, but they are not designers on the team. Occasionally, where their role has led to significant changes in design, the design reviewer will declare themselves conflicted and call in another reviewer; this happened to the author on one occasion.

4.4.3 Importance of the Design Review

From practical experience, for an individual project, the process of preparing and delivering a design review can often be quite unsatisfactory, especially – as frequently happens – when the review is the only time the reviewer comes into contact with the design process. In the early years of the Commitment Agreement, most design reviews were ignored, while some were angrily denied. Having a thick skin is a fairly important qualification for a design reviewer: even now a review can prove to be confrontational experience and does not always engender collegial responses from the design team.

In the first 5-7 years of Commitment Agreements it was a frustrating – if financially rewarding – duty of design reviewers to assist in retrospectively fixing buildings that had failed to meet their targets, usually after the design tem have ignored the same reviewer's report. While the "I told you so" aspect of such engagements was frustrating, equally revealing was the discovery of failures not picked up in the original review.

One difficulty of the design review process is that it is to some extent doomed to fail, as by the time there is sufficient design to review, it has become hard to change any of the major features of that design. As a result, the influence of a design review on a project is often limited to malleable features such as HVAC controls, attention to detail during construction and commissioning, and post-construction monitoring, while more fundamental design issues go unaddressed.

The true importance of the design review, therefore, has not necessarily been its impact on the specific building being reviewed. Instead, its main role has been to upskill the industry by placing a large amount of design advice in front of the design team, some of which almost inevitably permeates into the next building project. As a result, there has been significant movement in design for energy efficiency over the duration of the Commitment Agreement, much of it in areas that have been repeatedly raised in design reviews. A classic example is using variable pressure controls for fan and pump control; when first mooted in design reviews in 2004-2005, these were well outside normal practice and there was no real understanding of how best to implement them. Today, effective implementation is well understood and standard design practice. In an industry that lacks strong communication mechanisms (and indeed, has no local tertiary education), the design review process has been a significant tool for upskilling the HVAC design industry.

4.4.4 The role of simulation

At the time the NABERS Commitment Agreement was formulated, the intention was for the simulation to be there to prove that the targeted rating was achievable, and indeed design teams conducting their own simulations will typically ensure that the simulation report reflects this before it is handed over for review. Experience shows that the most common criticism by reviewers relates to the lack of sufficient detail to enable review, followed by concerns about the adequacy of certain aspects of the modelling. While these concerns are sometimes responded to in a revised report, they are frequently ignored, or at least not clarified with the reviewer.

If there was significant evidence that it was difficult for buildings to achieve the 4.5 to 5 star ratings typically being targeted, this would be a major concern. However, in practice it has become clear that practically any modern design[22] are capable of achieving 4.5 stars in practice, and that practically all buildings simulated now come out at 5 stars or above[23]. As a result, the simulation is of limited value in informing the design review.

[22] And indeed many less-than-modern designs

[23] Indeed, many buildings simulated at 4.5 stars, have later gone on to achieve 5 stars in operation. This suggests that the lower prediction was more a matter of conservative assumptions in the simulation, than of design limitations.

There is however evidence that buildings that can score 5.5 stars and above are differentiated by genuinely superior design, not just average design combined with good tuning. In this higher performance range, simulation becomes a far more critical determinant of the review outcome, as a strong case is needed to show that the rating is capable of being achieved.

At this stage, however, almost all Commitment Agreements are at 4.5 or 5 star level; higher levels have only been targeted in three base building projects to date.

4.4.5 Post-construction autopsies

In its original formulation, part of the Commitment Agreement fee was charged to enable the NABERS administrator to call in the Independent Design Reviewer to undertake an on-site review for buildings that failed to achieve the target. This requirement significantly increased the Commitment Agreement cost and was rarely if ever utilised; as a result it was dropped early on in the history of the Agreement.

In practice, where such a process is conducted, it is typically at the behest of the building owner where they lack confidence in the design team to follow-through without external oversight. This occurs moderately regularly.

4.5 Application of the Commitment Agreement

The Commitment Agreement has been in place since 2002, during which time a total of 147 have been signed for base buildings. Commitment Agreement numbers have varied significantly over this period, peaking between 2008 and 2013; recent numbers have been relatively low as shown in Figure 5. This probably relates to changes in construction activity, together with increased confidence by the industry that it can build high performing buildings without oversight.

The vast majority of buildings have targeted 4.5 or 5 stars, as shown in Figure 6. This reflects a number of factors:

1. 4.5 stars is still the benchmark requirement for Government departments and thus many projects aim to reach this rating, and no more. However, it should be noted that when the Commitment Agreements started, 4.5 Stars was genuinely a “stretch” rating, with no track record of it ever having been achieved in use.
2. 5 stars has in recent years become the new informal benchmark for “high performance”, but it is only in the past 3-4 years that it has been achieved regularly.
3. 5.5 stars (and higher) , although increasing as a proportion of the market, is still relatively uncommon today, and industry knowledge of how to deliver it is not well formed, so making it a far greater risk as a commitment. Furthermore, the extent of tenant demand for this level of performance is not well established. Several projects that committed to 5 stars have gone on to achieve 5.5 stars, indicating some conservatism and risk management on the part of developers and designers.

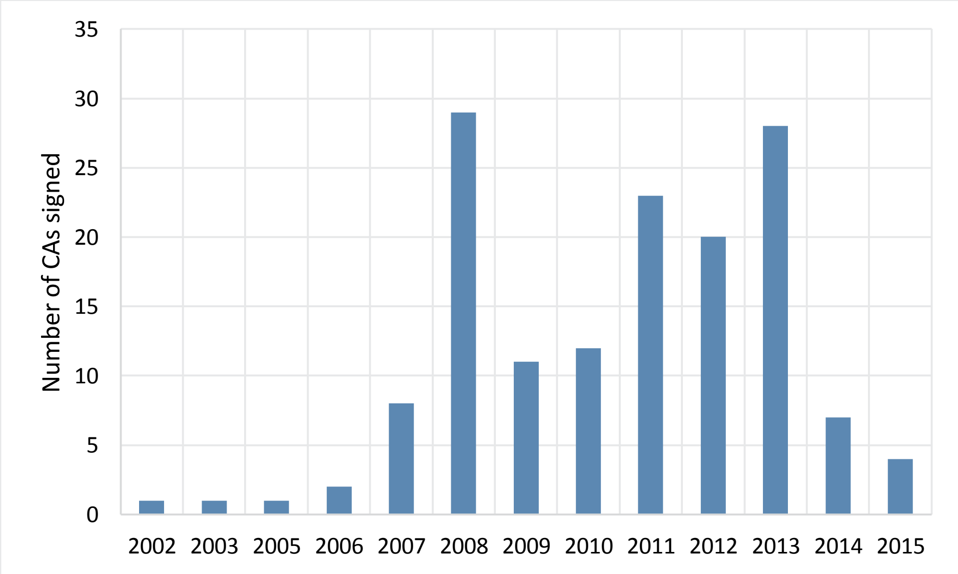

Figure 5. Commitment agreement uptake since inception

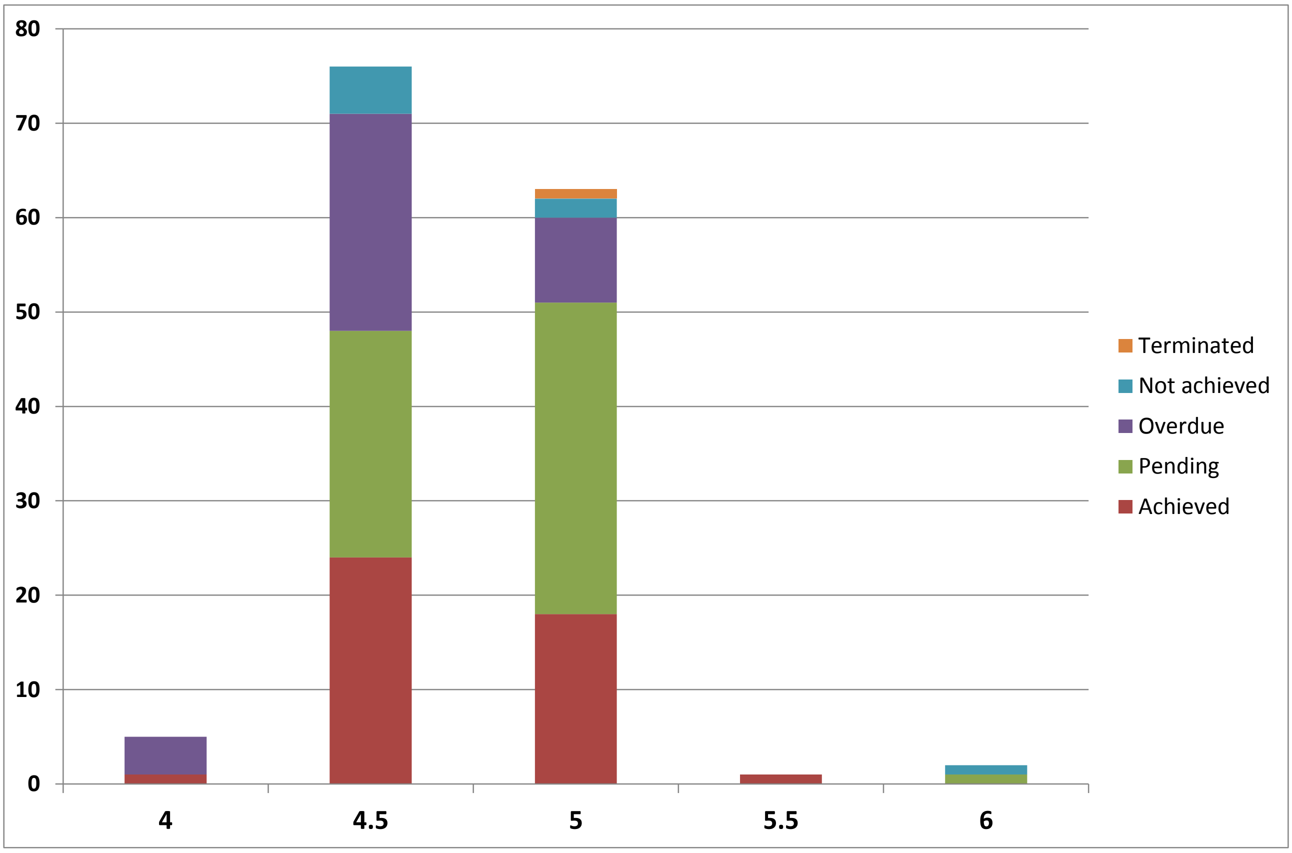

Figure 6. Number of CAs registered by target star rating[24].

[24] Data available from www.nabers.gov.au

According to NABERS official records, of the 147 base building Commitment Agreements to date[25], 44 have achieved their target ratings (in an average of 4.2 years), 8 have failed to achieve their target, 36 are overdue to register that they have achieved their target and one has been terminated. The remainder are in progress. Our independent investigations indicate that 4 of the failed buildings, 5 of the overdue buildings, 3 of the in progress buildings and the terminated building have since achieved target, bringing the current success rate of buildings that are not still in progress to around 63%.

The distribution of status, versus age of the agreement, is shown in Figure 7. In Figure 8, the percentage of achievement and average time to achievement is shown against the age of the agreement[26].

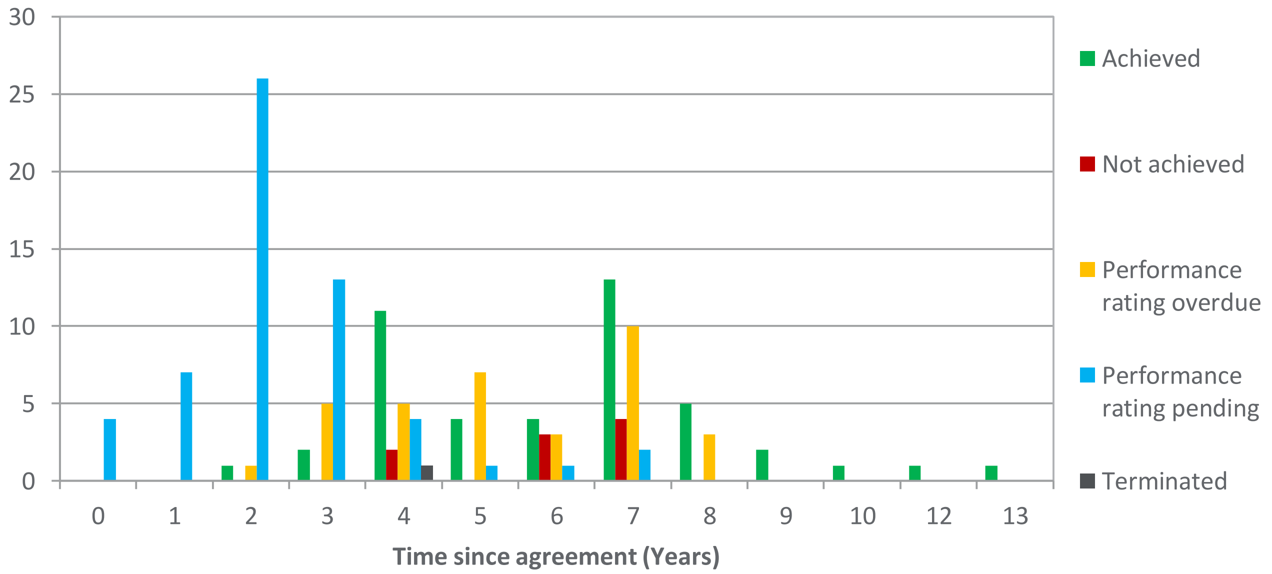

Figure 7. Distribution of Commitment Agreement results versus age of agreement

It is fairly clear from the data that target achievement has been challenging for many buildings, with high achievement rates only being reported in older projects. To put this in context, though, a Commitment Agreement should ideally be signed early in the design process, so allowing for a 1 year planning phase and a 2 year construction, plus one year minimum in operation, one would expect few agreements less than 5 years old to have been completed. The fact that a number of agreements have achieved their target more rapidly reflects the fact that some Commitment Agreements were signed late in the process, including during construction.

[25] There have also been 10 tenancy Commitment Agreements and one whole building Commitment Agreement
[26] We have used data available from the NABERS website to compile these figures; we have not updated these figures in line with our independent assessment noted in the previous paragraph.

The two key factors that delay the achievement of target, in practice are:

1. Technical failure, i.e. failure to get the systems to work with the planned efficiency; and
2. Vacancy, i.e. failure to get the building to the minimum level of occupancy (taken as 75% under the provisions of the Commitment Agreement) necessary to be able to assess at least one year's performance in use, before being able to finalise the Agreement.

In practice, both these factors have played a role; several projects the author knows of took up to 3 years to achieve 75% occupancy[27], while some early Commitment Agreements, in particular, failed badly on the technical front when first completed and have taken a long time to achieve performance – generally well after the original design and build team has left the site.

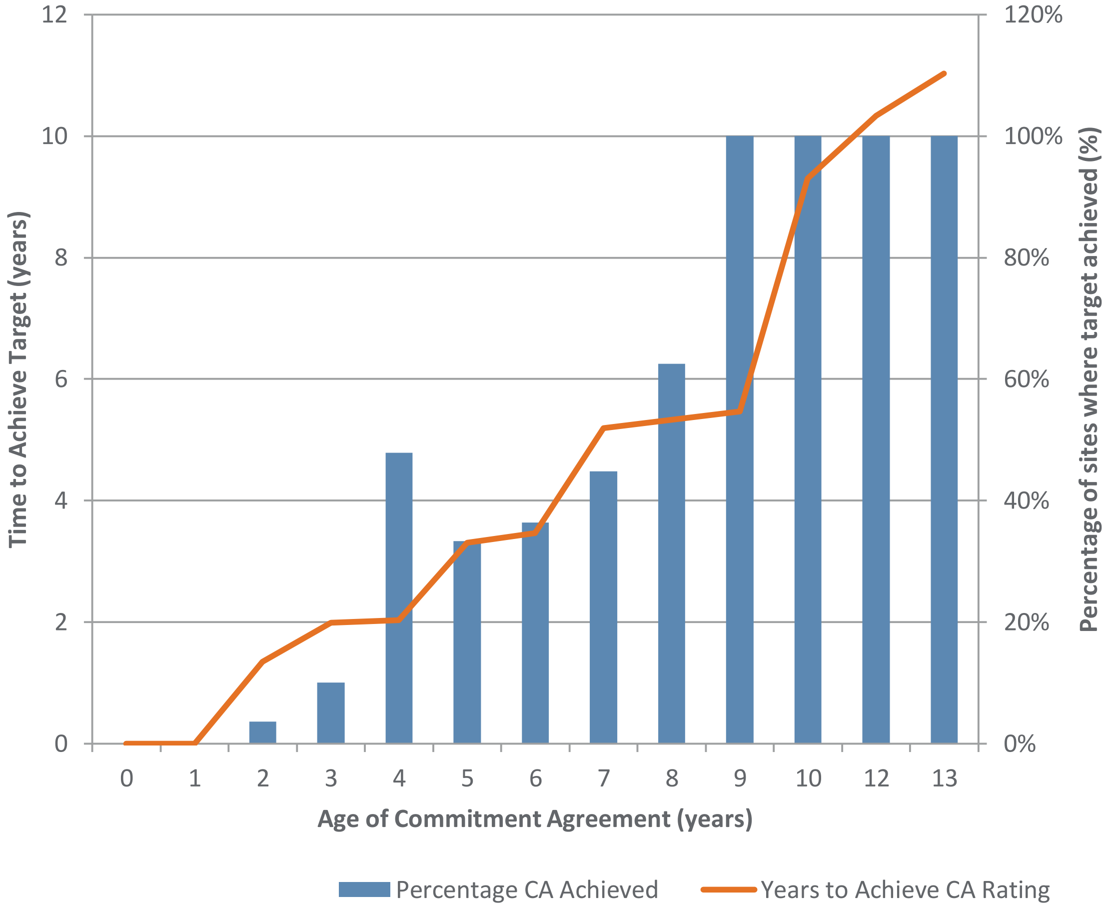

Figure 8. Rate of achievement and time of achievement for agreements of different ages. The Figure shows that the time to successfully deliver a Commitment Agreement is quite long, with only the oldest agreements showing high rates of success. Lower rates of success in more recent agreements reflects a number of factors: the long latency of agreements; the small number of agreements in the period prior to 2007 and the presence of a significant overdue rate in Commitment Agreements in the 4-8 year age range.

[27] These projects have often monitored performance during low occupancy periods, with the intention of declaring their rating at the earliest possible time. While the efficiency of the buildings in low occupancy has varied, the experience of the author is that once occupancy rates have reached 75% for 12 months, target ratings are usually be achieved

4.5.1 Successes and failures

It is clear from the data presented the process has taken quite a long time for some buildings, and success is not guaranteed. Buildings that have been able to achieve their targets in a timely manner have tended to have:

- A motivated project team, often with a client-driven requirement for the target rating
- Contractual obligations on the builder/developer to achieve the target
- Good on-site commissioning, frequently with an independent commissioning agent
- Monitoring and tuning process during the defects liability period
- Building fully tenanted within 18 months of practical completion

For these buildings, the project team will typically have utilised the independent design review mainly to inform control strategies, but may have also built on some knowledge from previous design reviews. Simulation will have been undertaken either by an independent or more often by the design team. Frequently the independent design reviewer will have been involved in assisting the monitoring and tuning process during the defects liability period.

Projects that have not been successful in achieving their targets tend to have:

- Commitment Agreement driven by external factors (e.g. development planning application requirement), rather than client or team motivation
- No contractual obligations on building/developer to achieve the target
- Industry-standard commissioning
- No monitoring or tuning process during the defects liability period
- Building not fully occupied within 18 months.

Typically any one of these factors can be sufficient to cause a delay in achievement. For these unsuccessful sites, the independent design review may well also have been commissioned very late in the design process – sometimes even well towards the end of construction – and will probably have been ignored completely. Simulations will have been conducted by the design team.

One notable “blind spot” relates to the signing parties to the Commitment Agreement. When a building is being built, the final owner may not be known, so the developer signs the agreement. However, on completion the building may then be sold, with the original party abdicating responsibility for the Commitment Agreement, with no guarantee that the new owner will accept the obligation as part of the sale. This has caused some Commitment Agreements to lapse; in the absence of the external pressures driving high performance irrespective of the Agreement, it is likely that none of the affected buildings would have achieved their targets.

It is fairly clear from this experience that the use of Commitment Agreements in a quasi-regulatory context, e.g. being included as a condition of a development approval, is relatively ineffective, as the terms of the agreement are too weak to enforce. Instead, the value of the Commitment Agreement lies in its ability to support and educate the market to achieve a result that the project already aspires to achieve[28].

4.5.2 Tenants and the Commitment Agreement

In some cases, cornerstone tenants require a Commitment Agreement to be signed as part of the lease deal. Unfortunately, experience shows that this rarely indicates a great commitment on the part of the tenant to efficiency – indeed, a general issue with NABERS in the Australian market is that the scheme has been very effective in instilling change in the efficiency of base buildings, but has had much less impact on tenants. This is arguably because the requirement of a good base building performance by a tenant is a simple, one-line procurement decision, by which many tenants may feel they have outsourced their efficiency obligations[29].

Tenants are far more difficult to engage with for many reasons, most particularly because the locus of control for energy related decision is rarely within the building. Tenants undertake fit-outs based on external advice, often working to fit-out guidelines developed by “head office”, and containing IT systems that are generally under control of a remote IT department. Furthermore, the tenants see energy as a small outgoing relative to salaries. Even where Green Leases are in place, the prescribed quarterly “Building Management Committee“ meeting (a meeting of tenants and landlord to discuss energy efficiency and broader sustainability issues) is often ineffectual, with fluid representation from tenant side and little headway on building performance issues, many of which are too technical for many tenants to understand and appreciate.

[28] Case studies of Soft Landings in the UK have reached similar conclusions: process alone is no substitute for commitment and leadership.

[29] This has led to an increasing dichotomy whereby 5 star base buildings are regularly operating with 2 star tenancies. It is indicative of the effective independence of the two ratings that this situation can occur, but it is clearly a sub-optimal outcome.

The lack of tenant engagement often plays out through the fit-out process, which will often be challenging for the base building design, not helped by the fact that fit-out design may be conducted by the tenants' consultants rather than the base building designers, leading to a lack of sympathy for the original design intent. Over time, building owners have responded to this by tightening rules over tenant fit-outs, and **often in new buildings they will insist that the base building consultants are used to design or as a minimum approve fit-out designs**.

4.5.3 Market drivers

The original demand for the Commitment Agreement came from new building developers, who were seeking to be able to advertise a prospective post-construction NABERS rating in order to attract tenants. In the absence of such a mechanism, these stakeholders felt they were at a disadvantage in relation to existing buildings that already had NABERS ratings.

To some extent this market driver has abated, not because of a reduction in demand for prime office base buildings with good NABERS ratings, but an increasingly realistic expectation that new buildings will perform well, whether or not they entered into a Commitment Agreement. Unless specifically requested as a condition by a cornerstone tenant, it is buildings that have significant uncommitted space that benefit most from being able to use the Commitment Agreement to advertise a NABERS rating prior to achievement of the performance outcome.

4.5.4 Regulatory drivers

The Commitment Agreement is not formally part of any regulatory instrument. However, it is quoted in two borderline regulatory situations:

1. The City of Sydney, in particular, has had a policy of including a requirement for a Commitment Agreement to be signed and provided to Council as a condition of development approval.

2. State and Federal governments have procurement policies in place to require minimum NABERS base building performance levels from leased buildings. Where new buildings are being built with an intent to lease to government tenants – or are specifically being built for such tenants – Commitment Agreements are frequently used to manage the question of base building performance.

Furthermore, while the Building Energy Efficiency Disclosure Act does not mention the Commitment Agreement, the market pressure created by mandatory disclosure clearly has the potential to impact on demand for the Commitment Agreement.

4.5.5 Drivers for Tenancy and Whole Building ratings

While the Building Energy Efficiency Disclosure Act was being developed, consideration was given to a requirement for NABERS tenancy ratings to be undertaken and publically declared. However, at the time, the Federal Government did not have a good understanding of landlord-tenant issues, and expected building owners to report tenant ratings. In the end, this concept was replaced by a tenancy lighting assessment, which more reasonably reflects services provided to the tenant by the landlord.

There is no drive from Government at any level to make tenancy ratings mandatory; only the voluntary CitySwitch program[30] drives specific activity in this area. Similarly, while the whole building rating can be used to meet mandatory disclosure requirements when the base building cannot be evaluated, there is no drive to make such ratings compulsory.

4.6 Lessons learnt for the UK

The key learnings to be taken from the Australian experience of Commitment Agreements are:

1. The Commitment Agreement is a voluntary mechanism whose primary benefit is educational. It is not an effective regulatory instrument.

2. The success of the Commitment Agreement in Australia has been driven by the success of NABERS as a performance rating for existing buildings. The extent to which the reverse mechanism will work (using Commitment Agreements for new buildings to increase interest in performance ratings for existing ones) is unclear.

3. The Commitment Agreement is most effective if it is signed by the long term owner of the building. However at the time of construction, this party may not be known, in which case it becomes particularly important that additional measures (or market forces[31]) are present to ensure that the developer delivers to the performance target.

4. The success of Commitment Agreements in Australia has paralleled a general raising of the game of the players involved in delivering prime office buildings over the last decade, at the same time as the market has attributed greater value to higher performing buildings. See sections 5.3, 6.5 and 6.9.

5. The process requirements for the NABERS Commitment Agreement are minimal and fall well short of what is required to actually deliver a high performance building. There is scope to increase the requirements beyond this minimum, potentially including:

[30] www.cityswitch.net.au
[31] e.g. long term owners signalling that they are seeking to add high performing buildings to their portfolios

a. An enforced requirement for the Commitment Agreement to be signed early in the design process.

b. An early design workshop to brief consultants (and contractors) on the Commitment Agreement process and to provide early design feedback.

c. At least a recommendation that achievement of the target is a required condition for release of retentions at the end of the defects liability period.

d. An independent commissioning agent process similar to that promoted by GreenStar in Australia.

e. A monitoring and reporting requirement in the defects liability period through to the achievement of the rating, possibly conducted by or subject to review by the independent design reviewer, and possibly reported to the building tenants from 12 months after occupancy onwards.

f. Use of the Soft Landings Framework.

5. Procurement Process and Market Factors in Australia

5.1 Ownership and organisation of the office sector

5.1.1 Ownership

The upper tier of the office sector in Australia is dominated by Real Estate Investment Trusts (REITs), notably DEXUS, Investa, AMP, GPT, Mirvac and CBUS. A significant second tier of REITs (Cromwell, Valad, Centurion and others) own smaller portfolios. The REITs are often listed on the stock market, but may also include unlisted trusts. All are characterised by exposure to shareholder sentiment and demand for ethical investments, and thus have been relatively amenable to the increased drive for high performance buildings.

A secondary but significant component of the market is owned by overseas corporate and private owners, particularly from Asia. Typical examples are CIMB (China) and GIC (Singapore). These groups are becoming increasingly active in the Australian market.

The balance of the upper tiers and the majority of the lower tiers of the office sector are owned by smaller ownership groups, often family-based, some smaller corporate portfolio owners including smaller REITs, and private local and overseas owners.

Overall, the secondary ownership groups have been slower to respond to the call for high performance buildings, although larger secondary owners including those from Asia are now quite active in seeking improved NABERS performance. Motivation for these groups is typically driven by the desire to maintain a high quality portfolio with appeal to upper-tier tenants; in turn it is now well established that high NABERS-rated buildings attract higher rents and better valuations, as discussed further in Section 5.6.

5.1.2 Leasing structures

The majority of leases for office buildings in Australia are net, i.e. the base building energy costs are passed through to tenants as an outgoing. Only a small number of gross leases (where the energy costs are aggregated as a fixed component of rent) are used in the upper tier office sector. As a result, the financial benefits of energy efficiency upgrades typically accrue to tenants rather than landlords.

Leases typically specify core hours of service for normal services operation. After-hours air-conditioning is charged at a flat rate per floor. In most cases this is market-determined ($30-60 per floor per hour is typical), with little or no relation to actual operating costs to service (which our studies indicate are often more like $10-$15 per hour).

A number of upper tier tenants use Green Leases, especially those from the government sector. These require a higher level of collaboration and communication between tenant and landlord on energy performance (and sometimes other environmental issues). They often include base building NABERS Energy requirements, but being mostly tenant-driven, do not always require tenancy NABERS Energy requirements.

5.2 Construction procurement processes

Building construction in Australia generally proceeds down one of two basic procurement paths:

- Full consultant design, where the design consultant undertakes the detailed design of the building, which is then tendered out to builders. The consultant is frequently novated to the builder to provide additional design during the construction process, or may remain contracted to the owner; both situations are fairly common.

- Design and build, where the owner procures a preliminary design from a design team and then tenders the design and build from contractors. The contractors will either utilise their own in-house design team, their preferred consultants, or the original design team consultants (on novation) to finalise the design.

Full consultant design matches the Commitment Agreement process better, because the design is available in a reasonable level of detail in a coherent package for review. This then enables both the simulation and the design review to proceed on the basis of a defined set of documentation.

By contrast, most design and build projects tend to work against the Commitment Agreement process. The only hold point for the documentation is the preliminary design, which is neither sufficiently detailed nor necessarily representative of the final design because the contractor may often significantly change the design concept[32]. As a project proceeds, documentation is generated on a continuous basis and is often at different stages of completion for different disciplines. This makes it difficult to identify a review point until well on in the process, and often too late to make sufficient changes.

Balancing these issues to some extent are the levels of receptiveness of consultants and contractors to alternative design suggestions. Typically, consultants are defensive about their design and less likely to adopt any recommendations, while contractors are more flexible.

[32] This is not always a negative; there have been cases where the Independent Design Review has been done early in the process, and the contractor has used this to significantly revise the preliminary design, often recognising that the energy efficiency recommendations also align with improved buildability and/or lower costs.

5.3 The HVAC design industry

The HVAC design industry in Australia is strongly affected by the lack of dedicated undergraduate training in building services: students undertake general mechanical or electrical engineering degrees which may have one or two papers in building services, and then join a consultancy where they learn how to design building services. Lacking a stream of new ideas and practices coming in at graduate level, the industry has tended to be conservative, and graduates are trained, rather than educated in their professional discipline. As a result, the industry has traditionally been quite resistant to new ideas: until recently one could almost identify a mechanical consultant's signature on a building purely from the similarity of the HVAC design to their preferred "house" model.

Over the past ten years, while the situation with university education has not changed, the industry has become far more innovative and enquiring. This probably reflects a range of factors including the influence of NABERS and GreenStar.

At the same time, projects have tended to reduce the role of services consultancies, with ever more design work being conducted in-house by contractors. The drain of skilled consultants into contracting has tended to deskill the consulting sector, which in turn has reinforced the trend towards greater use of contractors.

In 2015 it would be fair to say that much of the industry – consulting or contracting – has had exposure to NABERS in one form or another, is reasonably conversant with the needs of high performance office buildings, and is increasingly competent at delivering them. This has reduced the importance of Commitment Agreements in the market, especially as government procurement policy continues to target 4.5 stars, even though this is now seen as standard practice. Where buildings are aiming at 5 stars and above, the roles of the Commitment Agreement and of specialist consultants become more relevant.

5.4 Tenant fit-outs

As discussed previously, tenant fit-outs are typically either designed by the tenant's consultant under the review of a base building consultant or sometimes by the base building's consultant directly.

There have been competing trends in tenant fit-out over the past decade:

1. Lighting power densities have dropped significantly, with 5-6W/m² open plan installations becoming commonplace (open plan is the dominant fit-out design in Australian offices).

2. On-floor IT power densities have dropped significantly, with increased use of laptops and the universal replacement of CRT monitors with LCDs. At the same time, the power consumption and density of tenant server rooms has tended to increase, leading to greater demands for supplementary air-conditioning for these spaces. This trend may now be reversing, with servers moving off-site.

3. Design occupant densities have increased. While most offices are designed to the Building Code of Australia's default of 1 person per $10m^2$ NLA, fitouts are increasingly targeting higher densities, leading to increased demand for supplementary air-conditioning. Density figures appear comparable to equivalent figures in the 2014 BCO Guide to Specification.

4. Supplementary air-conditioning to meeting rooms has become widespread, with many fitout designs calling for supplementary air-conditioning in all meeting rooms for 4 persons and more.

The increased use of supplementary air-conditioning systems has created challenges for many buildings, as supplementary loads start to exceed the capacity of the base building systems to service them.

5.5 Standards and expectations

The Property Council of Australia's Guide to Office Building Quality (2011) provides an outline of market expectations for different grades of buildings. Key energy and services related parameters from this guide are summarised below based on the Guide's requirements for new (post-2012) buildings. The limited points of comparison between the Property Council Guide and that of the BCO do not suggest significant differences in requirement, other than to note a higher degree of formalised requirement in the Australia.

Item	**Premium Grade**	**A Grade**	**B Grade**	**BCO Guide**[33]
NABERS	≥5 stars	≥4.5 stars	≥4 stars	n/a
Total floor area: *Sydney/Melbourne CBD* *Brisbane/Perth CBD* *Elsewhere*	 $\geq 30{,}000m^2$ $\geq 25{,}000m^2$ $\geq 20{,}000m^2$	 $\geq 10{,}000m^2$ $\geq 10{,}000m^2$ $\geq 5{,}000m^2$	 $\geq 5{,}000m^2$ $\geq 5{,}000m^2$ $\geq 3{,}000m^2$	n/a
Floor plate *Sydney/Melbourne CBD* *Elsewhere*	 $\geq 1{,}200m^2$ $\geq 1{,}000m^2$	 $\geq 900m^2$ $\geq 800m^2$	 - -	n/a
HVAC Zone size *Perimeter/Centre*	 $75/100m^2$	 $85/120m^2$	 $100/150m^2$	$27/50\text{-}70m^2$

[33] BCO Guide to Specification 2014

Tenancy plug load allowance for HVAC	≥15W/m^2	≥12W/m^2	≥10W/m^2	Up to 25W/m^2
Supplementary cooling allowance	≥25W/m^2	≥20W/m^2	≥15W/m^2	Not specified
After hours zones per floor	4	2	1	Not specified
Cooling capacity redundancy	60% of design load	50% of design load	-	Not specified
Tenancy lighting efficiency	≤2W/m^2 per 100lx	≤2.5W/m^2 per 100lx	≤3W/m^2 per 100lx	Not specified
Programmable lighting control	Yes	Yes	-	Yes
Standby power provisions:				Not specified
Lifts	50%	1 lift per rise	-	
Safety Services	100%	100%	-	
House L&P	100%	50%	-	
Central Plant	50%	-	-	
Tenant condenser loop	100%	100%	-	
Tenant lights and power	50%	-	-	

5.6 Property valuation

The influence of high NABERS ratings on property financial performance has become apparent in the past 6 years, with work by the Investment Property Databank (IPD) identifying correlations between high NABERS ratings and improved returns as indicated in Figure 9 and Figure 10 below.

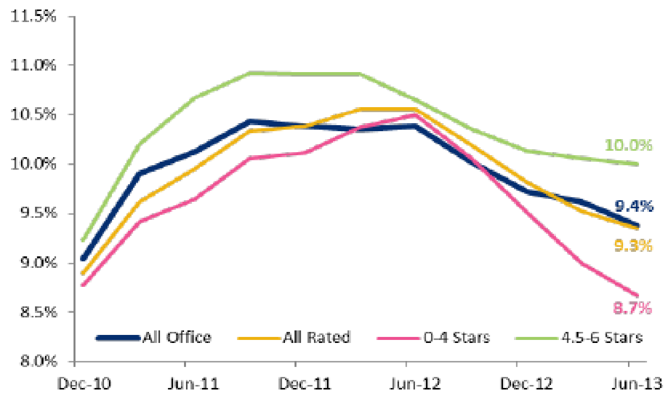

Figure 9. Office market investment performance Dec 2010 - Jun 2013 (Annualised total returns on quarterly periods). Source: IPD/Department of Industry NABERS Energy Analysis, Selected Charts Quarter Ending June 2013

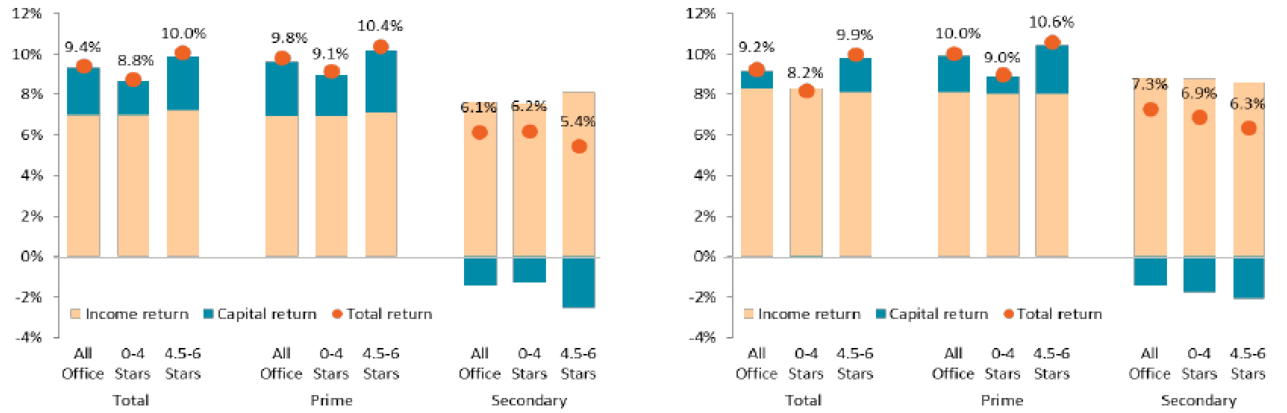

Figure 10. Office market returns for the year to 2June 2013 for the CBD (left) and non-CBD (right) markets. Source: IPD/Department of Industry NABERS Energy Analysis, Selected Charts Quarter Ending June 2013

It can be seen from the figures that the 4.5-6 Star NABERS rated buildings returns are 1.3-1.5% higher for prime properties. This will typically translate into higher property values in proportion to the increase in return; 2011 data indicated a 9% premium in property value for 5 star NABERS buildings[34]. Financial performance for high NABERS-rated secondary buildings was poorer than market average. IPD identified that this was probably due to a lack of geographical diversity in this component of the sample data set (which was particularly weighed towards the Brisbane market which was generally in decline through the data time period), rather than an issue in the performance of this group more generally.

The apparent achievement of higher returns for high NABERS rated buildings creates a significant market driver for NABERS improvement, as the improvement in return and capital value creates a payback on efficiency investment that vastly outweighs the energy payback.

[34] Australian Property Institute (2011). Building Better Returns: a Study of the Financial Performance of Green Office Buildings in Australia. http://www.api.org.au/folder/news/building-better-returns-research-report

5.7 What drives efficiency in the Australian office market?

The rapid and substantial improvement in NABERS performance in the Australian office market is of international importance; very few other sectors can claim to have improved average performance by 40% in 10 years. The question arises therefore as to what has driven this remarkable improvement.

It is fairly clear that the driving factor has been a simple commercial interaction between landlord and tenant: tenants have been seeking high NABERS spaces, so owners of such spaces have higher demand for their properties, which results in better building returns. The causality of this interaction is evident as soon as one moves out of the prime office sector; prior to mandatory disclosure there was no evidence of improvement or even interest from this sector. Interestingly, the "name and shame" aspect of mandatory disclosure has led to significant efficiency improvement activity in the second tier office sector, arguably out of fear that a poor rating might affect rental performance, irrespective of any known demand in this market segment.

Given that the primary tenant demand has been for 4.5 Star NABERS spaces, the continuing push for higher rated spaces – with 5 stars essentially the new benchmark for good performance – is being driven by a desire to stay ahead of competitors in advance of tenant demand, as only a minority of tenants are demanding 5 star space. This competitive atmosphere has driven a culture where – in some circles at least – ever higher NABERS ratings are seen as getting "one step ahead" of the market; there is considerable prestige accorded for instance to Australia's first new 6 star base building.

Outside these market factors it is relevant to point out that Australia does not provide an environment conducive to strong climate action; the previous Labor administration proposed but then rejected an emissions trading scheme; failed to gain popular support for its carbon tax; lost government to Tony Abbott who made getting rid of the carbon tax a central policy plank and who was quoted publicly as saying "climate change is crap" and "coal is good for humanity". In these actions he was strongly supported by a chorus of right-wing commentators in the Murdoch press which dominates Australian print media. So it is fairly clear that the efficiency argument is not being driven by the political discourse. Indeed, if there is a relationship between the political discourse and climate change related activity generally in Australia, it is an inverse one: the lack of political commitment to coherent climate policy has led to industry consciously taking the lead.

6. Building Design and Construction Practices in Australia

6.1 Building envelope

Typical modern Australian office buildings have a high window to wall ratio, using moderately high performance double glazed, low-e units with a solar heat gain coefficient of 0.35 or less. Most large buildings use a curtain wall construction and have little or no shading. Some buildings do opt for a built up construction with solid walls and windows with shading. There is some evidence emerging in the market of differentiation between standard and superior façade designs, possibly determining the difference between 5 and 5.5 star NABERS buildings, but at this stage this assertion is purely anecdotal.

Insulation is generally set to BCA (Building Code of Australia) compliance only, which for Sydney is R1.8 in walls and R3.2 in the roof (equivalent to U-values of 0.56 and 0.31 W/m^2K respectively).

Infiltration and building sealing are not a great focus in Australian office buildings. This is at least partly because the generally mild climate in temperate Australia means that overnight cooling through a leaky façade counteracts – or more than counteracts – the penalties associated with increased daytime infiltration in non-humidity controlled buildings, which comprise the vast majority of the population.

In general, **NABERS has had little influence on the architectural profession** - to date the majority of improvements have been to mechanical services design and operation. Consequently, façade and services tend to be poorly integrated, detracting from both the engineering services design and the overall efficiency of the building.

6.2 HVAC plant

The traditional and still dominant servicing approach for upper-tier office buildings in Australia is variable air volume air-conditioning. Modern systems are being designed with separate air-handlers for each façade and one or two centre zone air-handlers, with maximum air change rates of 8 to 11 on the perimeters and 3-5 air-changes in the centre zone.

Other cooling systems used in temperate regions for upper tier buildings include active chilled beams, passive chilled beams and various hybrids of these and VAV systems. A small number of displacement ventilation systems are also in use. Older system types include multizone and dual duct systems.

VAV terminals in new buildings are typically not fan assisted, except in Western Australia where the use of parallel fan assisted terminals is common; by contrast this practice is generally avoided in eastern states. VAV reheats are frequently direct electric but in the cooler climates (Canberra, Melbourne) hot water reheats dominate. VAVs are typically configured to control down to 30-50% of maximum flow to meet zone demand.

Economy cycles are used for most air-handlers in Canberra and Melbourne, but their use in Sydney is variable and essentially non-existent in Brisbane.

Airside heat recovery is rarely used in Australian buildings.

In smaller buildings, Variable Refrigerant Flow (VRF) and water cooled package units systems are common, and in some cases large ducted split systems. For chilled water systems above 800 kW capacity, water cooled chillers with cooling towers dominate.

Boilers are exclusively natural gas fired and even in new buildings range from quite crude atmospheric boilers to fully modulating condensing boilers. Condensing boilers have only become an accepted technology in Australia in the past 7 years. Hot water systems are generally configured as central services with primary-only or primary-secondary distribution, and most operate at fixed temperature.

Cogeneration and tri-generation systems were popular in the period 2004-2012, driven by GreenStar requirements, but there have been many issues in implementation with the result that many have been mothballed. Most commonly the issue has been lack of an adequate electrical load because the base building / tenancy metering split means that the cogeneration does not have access to the stable tenancy loads to support regular operation. This is less of an issue in Queensland, where chiller loads are steady, and States other than NSW and Victoria generally because the building metering arrangements permit export of electricity to tenants. Recent significant increases in the price of gas relative to electricity are, however, eroding the level of interest in cogeneration and tri-generation generally.

Hot water and chilled water systems are insulated to minimum levels prescribed in the BCA, but valves and fittings are frequently left uninsulated. For hot water systems in mild climates like Sydney, the limited demand for heating can often mean that a large part of the boiler load is associated with the heating of the thermal inertia of water and metal in the system on start-up rather than actually heating the building.

Property Council guidelines require 50-60% redundancy in central plant depending on building grade (i.e. if one item of central plant fails, there must be 50-60% of max building load available in the remaining plant). This tends to lead to installations using 2-3 chillers or boilers in most buildings; most commonly these are symmetrically sized (for instance 60%:60%).

NABERS' major impacts on HVAC design over the past 10 years have been:

- Increased use of low-temperature VAV systems
- Some experimentation with chilled beam and displacement systems
- Better zoning of AHUs
- Selection of more efficient chillers, fans, pumps and motors

6.3 Supplementary air-conditioning

Supplementary air-conditioning traditionally is provided by the use of ceiling mounted water-cooled package units (generally with electric heating rather than reverse cycle)[35].

Supplementary air-conditioning typically serves meeting rooms and server rooms only, although the recent trend towards higher occupant densities has resulted in an increase in the provision of supplementary air-conditioning to open plan areas, which has created some ongoing (and not yet fully resolved) challenges for NABERS assessment.

Most supplementary air-conditioning is controlled using local controls, typically a local switch and run on timer with a local, standalone temperature controller. Larger and more complex systems sometimes are controlled via a tenant BMS, although this is fairly uncommon. Linkages between base building controls and tenant supplementary system controls are often weak or non-existent; often this poses little difficulty as the supplementary system will be in an enclosed space that does not have local temperature sensing from the BMS for the central system. In open plan areas, good practice dictates that base building and supplementary systems are coordinated, either by controlling both from the base building BMS or by setting the operating set-points for the tenant system at the operating limits of the control band for the base building. However good practice is not always followed and conflicts are not uncommon in this situation.

In some situations supplementary air-conditioning is used to meet after hours demands, rather than operating base building services for this purpose. However NABERS provides no recognition of tenant supplementary air-conditioning run hours in the base building rating so while this practice is likely to have a negative impact on the tenancy rating it will have no effect either way on the base building rating.

[35] Condenser water for these is provided by the landlord as a 24/7 whole-of-building service (which forms part of the base building energy coverage). Some buildings provide supplementary chilled water and hot water rather that condenser water, but this tends to result in poorer NABERS outcomes especially if 24/7 loads are connected.

6.4 Other energy uses

Most buildings provide circulating domestic hot water to common area amenities which will typically comprise male, female and disabled toilets plus a small kitchenette on each floor. Typically tenancy kitchens and such like are also connected to these systems. In most buildings domestic hot water is gas generated, although some buildings use heat pumps. Use of direct electric heating, although fairly common in older buildings, has largely been eliminated by recent changes in the BCA. **The low heating loads in Australian buildings mean that domestic hot water systems are typically fully separated from space heating systems.**

Lifts in new buildings are most commonly high efficiency variable speed variable voltage AC lifts with regenerative brakes. Most lifts use conventional controls although there is some use of destination control.

Common area lighting varies with architectural demands but is frequently based on downlights (typically LED), most often on some form of timer control. Lighting in fire stairs is increasingly trending towards the use of two-level LED lights with local movement sensors. Use of external lighting for architectural purposes still occurs but is frequently disabled shortly after the design team leaves the site; external lighting for safety increasingly uses LED sources.

Most of the technology change in this area of energy use has been driven by technological opportunity; NABERS has provided some background motivation for early adoption.

6.5 HVAC controls

HVAC control is recognised as a major driver of building efficiency and has become increasingly focal in new building design and delivery over the past 10 years, during which time the industry has upskilled significantly. NABERS has played a very significant role in this change. Typical control approaches are well summarised in AIRAH DA28 Building Management and Control Systems (BMCS)[36].

[36] Examples include:

- Hardware: Full DDC with electronic actuators, typically with webserver remote access.
- Air-handlers: variable static pressure control for fan VSDs; supply air temperature reset based on nominated (average, high select) control zone; enthalpy controlled economy cycle.
- Terminal units: 1-2°C deadbands between heating and cooling; proportional control of heating and cooling across 0.5-1°C proportional bands.
- Chillers: Variable chilled water temperature control. Staged up based on supply chilled water temperature and/or chiller load; staged down based on chiller load.
- Boilers: Fixed hot water temperature control for most sites, some use of variable temperature control especially where condensing boilers used. Staged up based on supply hot water temperature and staged down based on return water temperature
- Pumps: variable static pressure control for pump VSDs

6.6 Complexity

Traditional Australian office buildings are relatively simple and have little other than HVAC, lifts and lighting. However GreenStar has pushed some complexity into building design, both in terms of the use of more complex HVAC approaches (such as chilled beams and chilled beam hybrid systems, both of which drive a significant requirement for humidity control), and in terms of the addition of extra technologies such as black and grey water treatment, cogeneration and tri-generation.

A result of this has been that many of the top-flight green buildings are considerably more complex than their traditional counterparts. This causes problems in operation and efficiency which the industry is still grappling with. Thus, for instance, chilled beam buildings are often using poorly designed dehumidification systems, cogeneration and tri-generation systems have been mothballed and black and grey water treatment plants have been turned off. The irony is that these systems have made the building considerably more difficult to operate and often have delayed (but rarely prevented) achievement of NABERS targets.

In general, although NABERS has contributed to the use of cogeneration and tri-generation, it has been a secondary driver of complexity as it is reasonably well understood by the industry that a well-designed VAV system can be made to achieve 5 star NABERS without major difficulty; the use of other more complex systems tends to be driven by GreenStar considerations.

6.7 On-site renewables

The use of on-site solar power generation on office buildings, particularly the lower-rise, large floor plate variety, has been increasing rapidly over the past 3 years and is playing an increasing role in crossing the 5.5 and 6 star boundaries. Due to a distortionary effect from the structure of Government incentives, most installations are less than 100kW, but this author’s company is involved in a site which has a 400kW PV array installed as part of the original design.

NABERS has been a significant driver for adoption of on-site PV. This has been driven by a number of factors:

- The cost of PV has dropped considerably during a period when power prices have risen significantly, with the result that paybacks are now typically 5-7 years

- The proverbially sunny Australian climate makes solar particularly effective: in Canberra for instance, solar generation for a well oriented panel is in the region of 1300-1500kWh per kW peak installed per annum, which is far higher than the UK (typically 900kWh or less)

- As buildings reach the limits of their efficiency performance, PV is becoming a reliable and relatively cost effective means of adding typically 0.25-0.5 stars to the building rating.

6.8 Metering

In NSW and Victoria, electricity regulations have driven the separate utility metering of tenants and landlords, which has in turn created the base building/tenancy split that has been fundamental to the success of NABERS. In other States, tenants are typically monitored on a landlord-owned embedded network using landlord-owned meters. Electricity is sold on by the landlord at a profit determined by the difference between the scheduled tariff rates prescribed by the State electricity regulators and the bulk contract electricity pricing available to the building owner as a larger user.

Sub-metering for diagnostic purposes has become the norm in upper tier buildings, although the quality of configuration, commissioning and available insight varies widely. As a whole, diagnostic sub-metering systems are under-utilised in most buildings, not helped by often poor quality interfaces. A number of companies provide on-line interfaces that upload data from these systems and provide interpretative services, but this is still an area in which the industry has yet to settle on a comfortable pattern, with adoption of different approaches to metering and diagnostic services being quite volatile.

Commissioning of sub-metering systems is a significant challenge, with error rates on basic configuration – k-factors, CT polarity and the configuration of remote meter reading systems in particular – being as high as 25% in some new installations. Some time ago, NABERS imposed rules on the validation of non-utility metering: this has gone some way to addressing this issue, but it needs pushing further.

In 2014-2015, significant inroads are being made by automated fault diagnosis systems, particularly at the upper end of the market, which use algorithmic checks to test for common maintenance failures in the operation of the BMS, such as broken valves and dampers. These have typically been presented as an alternative to sub-metering, even where the sub-metering already exists. It is not yet clear how this trend will develop and what impact it will have on sub-metering buildings in the future.

6.9 Commissioning

As with most countries, Australian commissioning standards have historically been poor, and it is only in the past 5 years that this has been recognised as a focal issue for building performance. To put this in context, even the inclusion of improved commissioning requirements in GreenStar (launched in 2003), including the use of an Independent Commissioning Agent on most projects, did little to improve the NABERS performance of some of the first GreenStar buildings. However, as NABERS performance has become more focal, commissioning has been recognised as an important component of overall delivery.

The most commonly referenced commissioning standards are those from CIBSE, which appear to be the best in the market across most system types, expect for chillers (which the CIBSE Commissioning guides do not cover). ASHRAE Commissioning guides are also referenced on some projects. At a detail level, test methods are often taken from NEBB (US). AIRAH also produce a commissioning guide although this provides little new beyond the other references.

The use of an effective Independent Commissioning Agent does appear to be one of the important success factors for commissioning; when this is done properly, it ensures that commissioning is considered from the earliest stages of specification and thus provides a far greater assurance of success, providing that the project managers understand and support the ICA role, rather than seeing it as an interference.

6.10 Defects Liability Period tuning

For successful delivery of NABERS outcomes, monitoring and tuning during the Defects Liability Period has been found to be essential. Most typically this includes:

- Establishment of building and subsystem targets based on the simulation
- Monthly monitoring reports comparing sub-metered performance to simulated predictions
- **At least 4 tuning exercises during the course of the defects liability period**, each including a detailed review of BMS operation
- Continued commissioning activity to identify and rectify commissioning defects
- Contractual retentions on the builder and mechanical contractor based on NABERS performance (i.e. NABERS performance failure is treated as a defect)
- End-of-period formal assessment of NABERS Rating prior to contractual release.

Buildings that have undergone this process adequately have been able to achieve their NABERS targets within 12-18 months of 75% occupancy.

6.11 Discussion

6.11.1 Are practices improving?

In general, the design, construction, commissioning and tuning of prime office space have improved significantly over the past 10 years. This is directly demonstrable in the fact that **in 2000-2005 there was no discernible difference in average NABERS performance between existing buildings and new buildings**, whereas now, new buildings in this sector are regularly delivered to 5 stars and above, a level of performance never achieved 10 years ago.

This has included improvements in all areas of practice, including better equipment selection, services design, metering design, commissioning, control and tuning, although individual projects may fall short in individual areas. **Probably the area of least improvement has been architecture**, as building facades continue to be designed with limited reference to efficiency objectives.

It is reasonable to argue that Australia has created somewhat of a hub of excellence in this area, as design for performance definitely requires a set of skills and measurements that have not been available for most markets. As a result, there would be significant potential for the UK to benefit by utilising Australian expertise in this area rather than repeating the 10 year learning curve that Australia has experienced.

6.11.2 Design for compliance versus design for performance

All new buildings in Australia have to comply with Section J of the Building Code of Australia (BCA), which sets out minimum requirements for all major aspects of building design including insulation, glazing, mechanical services equipment selections and some aspects of design, lighting design and some aspects of metering. Code stringency levels are quite mixed, with aspects of the glazing requirements being quite difficult to comply with directly, while some mechanical component efficiency requirements are well behind normal industry practice. In common with most overseas building codes, the BCA offers a simulation based method whereby a non-compliant building can be tested against a compliant building to prove that the integrated result is superior to the elemental compliance model.

Actual rates of real-world BCA compliance are not known. Australia uses a private certifier system for BCA compliance, which in turn tends to devolve responsibility for detailed compliance to the design team, which in essence leads to best-intentions compliance.

Design for performance of necessity goes well beyond compliance, as it is well established in Australia that a fully compliant, high Green Star building (thereby simulated at a high level of efficiency) can return a very poor NABERS rating if issues relating to control, tuning and commissioning – none of which are really addressed under the BCA – are not correctly addressed[37]. In a mandatory disclosure environment, there is clear pressure for a building to achieve a good NABERS rating, so this is often incorporated into the builder's contract, whether or not there is a Commitment Agreement; **indeed this practice has to some extent superseded the Commitment Agreement as a preferred industry approach to the problem**.

[37] Conversely, buildings of average design with excellent commissioning and control can achieve high NABERS ratings.

7. Post Occupancy Operation

7.1 Characteristics of Successful O&M for NABERS

The major office portfolio owners have made substantial steps towards the upgrade of portfolios to a 4.5 star average (from a 2.5 star average, with a 40% reduction in emissions intensity resulting). This achievement was not without false starts, and initial efforts by most portfolios were flawed and unsuccessful. Similarly, as these portfolios have moved into a “hold” phase, where they are attempting to keep ratings at 4.5 stars or above, some sites are succeeding while others are suffering from degradation of the rating.

Factors that drove the successful implementation of NABERS in the upgrade phase were:

1. Presence of a clear target for performance. Activity only started at site level when the high-level decision to achieve a portfolio average[38] of 4.5 stars was made and publically committed to.

2. Incorporation of NABERS into KPIs. Some portfolios met significant internal resistance to NABERS upgrades in the early phases. Successful portfolios incorporated NABERS KPIs into the performance evaluation and bonus schemes of their building and property managers as a means of avoiding this.

3. Setting a budget[39]. While there are many low-cost approaches to building upgrades, the 40% emissions reductions achieved required significant capital investment. A budget allocation for upgrades was therefore needed. This budget was typically justified on the basis of improved asset performance (value, vacancies, rents, tenant quality)[40] and environmental positioning for attracting international investment.

4. Treatment of the upgrade programme at portfolio level. Maximum process efficiencies were achieved where a dedicated internal team worked on the upgrades across multiple buildings. This allowed the key implementation team to become experienced and learn lessons from project to project.

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[38] The population distribution in Australia means that the majority of office buildings are in NSW and Victoria. However, all the major portfolios that committed to NABERS Portfolio averages were national, typically with significant assets in the other States; rectification of metering issues was often a first step irrespective of location.

[39] Actual costs of upgrades vary widely. Analysis of available data suggests that the cost of upgrade for buildings starting at a rating below 4 stars is of the order of $100/m² per star.

[40] Anecdotally, one of the major portfolios reported an average 5 year payback on energy cost alone for their NABERS upgrade program, which took their portfolio from a 2.5 star average to 4.5 stars. This same portfolio rationalized a $2m upgrade to a Canberra building with an annual energy cost of $400,000 on the basis that if they didn’t get the building to 4.5 stars they would lose $600,000 per month in rent through the loss of a government tenant. On this basis they considered that the project payback was closer to 3 months.

5. Appropriate use of external skills. Portfolios achieving high NABERS improvements almost exclusively made use of some external resources in key roles to identify and supervise upgrades. These resources included specialist energy efficiency consultants, mechanical and electrical contractors, and services consultants. **The suitability of these resources depended primarily on individuals within the team rather than necessarily the nature of the organisation; good and bad examples of work by each type of organisation exist**.

6. Regular monitoring of NABERS performance. As a minimum, portfolios moved very early on to annual NABERS ratings, well before these became mandatory (under the Building Energy Efficiency Disclosure Act 2010). Most portfolios moved to monthly tracking of NABERS rating.

In the "hold" phase, the parameters for success have changed to some extent:

- Targets. Most portfolios have held to the same targets as previously. However those that have committed to further improvements in NABERS performance have generally performed better, because the focus on NABERS ratings was not lost.

- KPIs for Personnel. Continued use of NABERS as a performance KPI for building and property managers remains important.

- Budget. Budget still needs to be available for upgrades, both for better than like-for-like equipment upgrades/replacements and for the continued improvement of building design and control. This includes replacing or upgrading controls systems earlier than might have been the case under business as usual.

- Monitoring. Successful buildings have almost inevitably used some form of close monitoring either via metering and reporting or, more recently, using automated fault diagnosis systems. Most systems work on a monthly reporting cycle.

- External resources. Continued use of external resources for monitoring, tuning and supervision of capital works is beneficial to results. In-house resources generally do not have the skills or time to devote to these sorts of activities.

- Tuning. Continued regular revisiting of the controls operation, followed by implementation of tuning measures, is necessary to prevent decay of control function.

7.2 On-site Personnel

The 'Low Energy, High Rise' project[41] (LEHR) identified clearly that building personnel were critical to the NABERS performance of buildings. In particular:

[41] http://thewarrencentre.org.au/lehr2/

- Building managers who thought they understood more about energy efficiency generally ran more efficient buildings. In the absence of any qualifications that correlated with performance, the study had to use the self-assessed level of energy efficiency knowledge of building managers.

- Provision of energy efficiency training was strongly correlated with improved building performance.

- Building managers who had conservative or average attitudes to energy efficiency tended to operate less efficient buildings. Anecdotally, in several prominent buildings for which NABERS improvement has been slow, it is fairly clear that a critical factor in the delay is a building manager who is uninterested or unconvinced by energy efficiency arguments[42].

- In-house building managers tended to outperform outsourced building managers. Taken in context with other results, the LEHR team interpreted this as not necessarily meaning that this direct result was true, but that as a minimum, building managers need to have some reason to care (either through incentives or corporate ownership) to excel in efficiency management.

The extent to which the job market for high-achieving building managers has changed over the past decade in Australia is unknown.

7.3 Drivers for Performance at Portfolio Level

The demand for NABERS performance at portfolio level has been driven by two key factors:

- **Tenant demand.** As discussed in Section 5.6, the requirement by government and some corporate tenants for high NABERS ratings has led to a significant correlation between higher rents, lower vacancy rates and good NABERS ratings. These factors then pass directly through into building values. This has made the adoption of high performance requirements a simple commercial decision.

- **Investor/shareholder demand.** The REITs that dominate the market operate a range of listed and unlisted trust portfolios which are reliant on attracting external investors, and most if not all report their sustainability performance through forums such as GRESB and GRI as well as on their websites. In a financial market increasingly dominated by the sentiments of aging baby-boomers seeking to invest their superannuation savings, there is a significant demand for green – or at least greener – investment options. Indeed one of the most significant early NABERS-related market transactions was the investment of $200m into Colonial's property portfolios by Vic Super around 2004 – based on the fact that they had rated their portfolio.

[42] In the cases directly known to the author, these were buildings with premium locations and very high industry profile that therefore had little need to worry about loss of tenants.

8. A Commitment Agreement for the UK

Given the above analysis, it is worthwhile to project what options exist for a Commitment Agreement in the UK, and how it might be structured.

8.1 Commitment Agreement Process

The Commitment Agreement should be required to be signed by no later than preliminary design, and certainly not be permitted to be signed late in the design (or indeed the construction) process as has occurred in Australia.

The requirements of the Commitment Agreement should be more prescriptive than in Australia, reflecting a fuller, project-long commitment, including:

- Contractual requirements for the achievement of the target
- Preliminary design workshop
- Design review
- Simulation
- Independent Commissioning Agent
- Post-occupancy M&V
- Soft Landings

The design team should be required to submit a response schedule to the design review.

8.2 Commitment Agreement Metric

The Commitment Agreement should either be assessed against:

1. The Landlord Energy Rating (LER); or
2. A simulated target produced to a well-defined protocol, for buildings where the LER does not apply. Note that the development of such a protocol is non-trivial.

It is understood that the LER currently exists only in prototype form. It would need to be consolidated into a formal scheme, with a Rule Book, and there would need to be a process for training and accrediting assessors and providing QA of accredited assessments.

8.3 Commitment Agreement Management

The Commitment Agreement should ideally be signed by the long term owner of the building or by the developer. In the situation where the building is sold mid-process, a failure to transfer the Agreement to the new owner should be treated as a failure to meet the terms of the agreement.

The authority managing the Commitment Agreement should ideally be a government department, the local authority, or a not-for-profit non-government organisation.

Sanctions for failure to meet the conditions of the Commitment Agreement should include the right of the managing authority to inform tenants and investors as to the failure.

An Independent design review panel should be overseen by the managing authority. Membership of the panel should be based on demonstration of experience in both new building design and construction processes and post-construction energy auditing and tuning.

Simulation users should not require tested accreditation specifically related to the Commitment Agreement. However, **a requirement for registration and completion of a course in the methodologies for simulation for Commitment Agreement purposes should be considered**. By combining this with more general training on the delivery of high performance buildings and the commitment agreement process, a good deal of industry knowledge could be transferred efficiently in the start-up phases of a Commitment Agreement scheme.