CLOSING THE GAP BETWEEN DESIGN AND REALITY OF BUILDING ENERGY PERFORMANCE

Strategies to address operational phase factors

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Executive Summary

For this report, the research team has been working towards identifying and developing strategies to overcome the factors, in the operation stage, that contribute to the energy performance gap of retrofitted office buildings projects. This research effort is built on the previous report (Report 3) that identified and categorised these factors in the operation stage.

Solutions, measures, feedback, and advice were collected from the literature as well as from interviews with professionals of Buildings Services and Facility Management, to identify the existing strategies to prevent or overcome the performance gap.

The identified strategies have been considered under the following five themes:

1. Monitoring, tracking and fine-tuning
2. Collaboration with the occupants and the leasing agent
3. Facility management training and support
4. Documentation
5. Energy efficiency related tax incentives

These strategies have then been incorporated into a 'Closing the Gap' framework (in the Appendix), focusing the operational staff/facility managers to minimise the energy gap in the operation stage. The research also looked at existing frameworks such as the 'Soft Landings' methodology and the 'nDeep' framework to enrich the findings.

Finally, the research team proposes a new approach called 'Total Facility Management' based on a more structural change to performance-based contracting of Facility Management. In this approach, building performance and tenant satisfaction are delivered to the building owner as an integrated service with a fixed fee for all services related to building operation and maintenance, as well as energy and water bills and a variable fee based on tenant satisfaction. This could be designed and promoted by Australian Sustainable Built Environment Council (ASBEC) or mandated through the Council of Australian Governments (COAG) by state governments.

Contents

1 Introduction

Many studies have shown that the majority of office buildings do not operate at their designed energy efficiency (the Warren Centre for Advanced Engineering, 2009) and this creates uncertainty about the return on investments of well-proven measures that could be introduced in retrofitted buildings. This report is part of the SBEnrc/ARC project 'Closing the Gap between Design and Reality of Energy Retrofitted Buildings'. It follows Report 3 where factors, in the operation phase, that contribute to this gap were identified and classified into five different categories. The two preponderant ones, given attention in this report, were the controls of the building services and the occupant behaviour. For this report, the research team built on the findings of the previous report to identify and develop strategies to overcome or mitigate these factors.

2 Literature review and feedback from industry professionals

As noted in the previous report, the operation phase is rarely a topic on its own when researching or reporting on the energy performance gap in buildings. This report has re-visited some of the references from the previous report but mainly used new references on strategies to close the performance gap. The research team also looked into reports about the factors in the operation phase that contribute to achieving high-performance low-carbon office buildings. Though this is a different topic, the greater challenge to achieve high-performance produces some lessons learned that could inform the findings on the gap between predicted and actual performance.

Finally, the research team interviewed again a few of the industry professionals interviewed for Report 3, to get their feedback and opinion on the framework proposed. They are:

Patrick Jeannerat (MSc) is Sustainability Manager at Colliers International. Patrick has been working in sustainability roles within Australia's built environment for over ten years, supporting design with ARUP, construction with John Holland and now operations with Colliers International. Patrick holds relevant professional assessor accreditations under the NABERS and Commercial Building Disclosure (CBD) programs and is an accredited professional under the Green Star Design, As-Built and Performance, and the WELL Building Standard.

Andrew Crabtree (MSc) is the director of Crabtree Engineering Software and developer of iSynapse, an analytics and diagnostic software package for Building Services. Andrew has been working in different engineering and management roles in Building Services and Facility Management since 1970 and was the Director of the commissioning management division of IBMS from 2007 to 2014.

Marc Atherden (BSc) is a Sustainability Consultant/Associate at Norman Disney & Young (NDY) in Perth. Marc has a mechanical engineering background with over ten years' experience in sustainability roles within Australia's built environment and holds professional assessor accreditation under the NABERS program.

Gary James (BSc) is a director at Jones Lang LaSalle (JLL) in Perth and is responsible for JLL's Energy and Sustainability Performance Analytics (ESPA) platform to deliver cost, performance and brand benefits to clients. Gary has 30 years' experience in Building Services and Facility Management.

Energy tracking and performance gaps in office buildings are one of his top priorities. Gary holds professional assessor accreditations under the NABERS and Commercial Building Disclosure (CBD) programs.

From the literature review and the interviews, the research team identified the strategies under five themes which then became the five sections of the framework presented at the end of this report:

1. Monitoring, tracking and fine-tuning
2. Collaboration with the occupants and the leasing agent
3. Facility management training and support
4. Documentation
5. Energy efficiency related tax incentives

3 Monitoring, tracking and fine-tuning

The previous report identified *Control of Services* and *Efficiency of Systems* as two major categories of factors contributing to the performance gap. Affecting both of these, is the monitoring capability of the Facility Manager (FM) which, according to The Carbon Trust, is necessary to understand the breakdown of the energy use and allow the system to take action to improve (The Carbon Trust, 2011). Assuming sufficient metering capability was provisioned in the design of the building and was properly installed during the retrofit, continuous monitoring of the building's energy consumption and the use of analytic tools to track the performance are necessary to ensure the building is operating as designed (Fedoruk et al. 2015).

Feedback from interviews: *Too often, the Building Management System (BMS) that monitors and controls the operation of the building, does not have the capability to analyse the data recorded finely enough. Consequently, the FM who is willing to track the performance of its building to be reactive if it drifts must spend precious time extracting and interpreting a variety of meter readings and other system(s) data.*

Feedback from interviews: *Building performance analytic software can help the FM better appreciate the level of importance and urgency of alarms triggered by the BMS.*

As pointed out by Fedoruk et al. (2015), the solution to this issue is offered by Analytic Software that complements the BMS. Figure 1 below is an example of the graphic representation from an analytic tool of monthly tracking of CO_2 emissions (related to energy use) in an office building, with reference to previous years as well as the corresponding NABERS energy star rating[1] and the targeted rating. The

[1] https://www.nabers.gov.au/about/what-nabers

latter is particularly important when the target is advertised or when a minimum rating is required by the tenant as is the case for government agencies who require 4.5 stars.

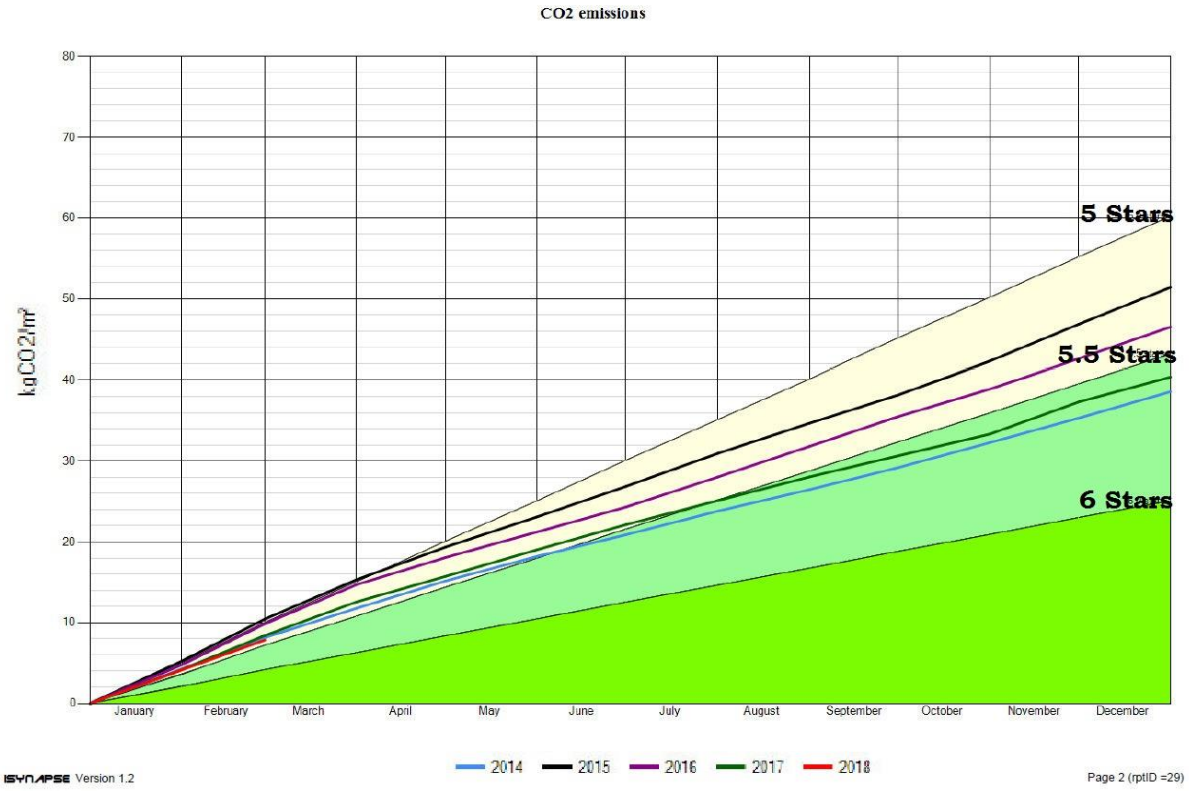

Figure 1 Tracking of carbon emissions with reference to corresponding NABERS star rating (Courtesy of Crabtree Engineering Software)

This tracking of the building performance against a reference such as the NABERS rating is expected from the FM, but this can be misleading if the actual conditions of operation of the building are not considered in the NABERS calculation. Indeed, if the NABERS assessors are considering the real rate of occupancy of the building, they rely on the hours of operation provided by the FM (from the BMS log) in their calculations. If this information is not available, they can only rely on the hours of operations mentioned in the Lease contracts or on industry standards.

> **Feedback from interviews**: *BMSs do not always capture after-hours HVAC use (and consumption) when calculating the NABERS rating, which leads to poor and misleading NABERS energy rating (more energy use for the same number of hours of operation). In this case, the solution is to add an analytic software that helps capture the after-hours operations or request the FM to keep a logbook in accordance with the NABERS requirements.*

Menezes et al. (2012) suggest that fine monitoring during operation is best complemented by Post-Occupancy Evaluations (POEs). POEs allow the FM to have another source of information to assess the building is performing as predicted and ensure the management of the building operation is not solely driven by meter readings and star ratings but also by tenant satisfaction. However, as one interviewee

noted, POEs are expensive to run, and as they raise the expectation that the FM would take all the suggestions into consideration, they are often followed by discontentment and even complaints. Instead, the interviewee suggested the FM should meet regularly with the tenants' management team, a measure detailed in the following section.

Fine-monitoring and tracking (and tenant feedback) should eventually lead to fine-tuning of the Building Services. Too often, this fine-tuning happens only within the first months following occupancy, but extending the fine-tuning over 12 months will give the opportunity to cross-check the performance of the building in all seasons. In its 2011 report, The Carbon Trust recommends recommissioning the sensitive weather systems in the opposite season of the year and perhaps during every season of the year, as does the Soft Landings method (Agha-Hossein, 2018).

> **Feedback from interviews**: *Building Services are here to achieve a certain quality outcome (thermal comfort, indoor air quality, lighting levels…). Therefore, the FM must know what those minimum requirements are (from the Design intent) before attempting to fine-tune the services.*

4 Collaboration with the occupants and the leasing agent

The second most important category of factors found in the previous report concerned the impact of the occupants on building performance. Report 3 explained how the usage profile of the building might not be the one that was predicted and considered in the energy simulation during the design phase. The performance gap related to the usage of the building can, therefore, be minimised thanks to the collaboration of the FM with the tenants and with the leasing agent, as described below.

4.1 Collaboration with the leasing agent

It is the duty of the FM to fine-tune the Building Services to achieve tenant's satisfaction while optimising the system for maximum efficiency and minimum energy consumption. However, there is a limit to what the FM can do. Drastic changes in the conditions of operation, such as a significant increase in the number of hours of operation, may sometimes be difficult or impossible to manage efficiently by the FM if the Building Services were not designed to operate efficiently under these new conditions.

> **Feedback from interviews**: *One interviewee referred to a situation he had encountered where a new tenant occupying a single floor in a mid-rise building, was running his business 24/7. The FM assessed the Building Services were not designed to supply air conditioning to only one floor and could only be turned down to supply five floors at a time. The solution, proposed to the building owner to regain the previous NABERS energy rating, involved modifying the controls of the Building Services (capital investment).*

The lesson learned from this experience is to have the FM assist lease agents in the negotiation of leasing agreements that do not follow the Designed Conditions of Operation.

Another interviewee mentioned that their organisation was often requested to run a fit-out review before a tenant moves in, which is a good practice of collaboration between the design team and the leasing agent during the operation phase.

4.2 Collaboration with the tenants and the occupants in general

Finer changes in occupant behaviour can be improved to match the behaviour simulated during the design phase. Indeed, models of occupants' presence and behaviours remain too simplistic (Mahdavi, 2011) and energy simulations assume occupants will have a very standardised and passive behaviour (Hoes, 2009), (Bonte et al., 2014) but human behaviour is complex and heterogeneous. It is particularly the case when occupants do not know or do not understand their environment and use their instinct to navigate and adapt. This can be the situation when a tenant moves (or moves back) into an office building that has been retrofitted and its staff is not briefed on the specificities of this "new" environment. It is therefore important to inform the occupants on the (new) building services and controls, encourage them to engage with the FM and make them aware their behaviour can impact their energy bills as well as the energy cost of the base building.

Lessons can be learned from the case of buildings retrofitted to achieve a higher than average performance. The aspiration for the building to achieve a certain star rating should be communicated to the occupants (Sustainability Victoria, 2016). Leaman & Bordass (2007) found that users of green buildings tend to tolerate deficiencies rather more than they do with more conventional buildings. Their study shows occupants' satisfaction is true for summary variables such as "comfort overall" even if when divided into their components, the favourable responses for green buildings are less clear-cut. This is because users understand the building operates in a certain way for a greater purpose than their individual comfort. This suggests that users should be informed or even trained to interact properly with the building and its services (The Carbon Trust, 2011). Research based on a substantial survey of 127 buildings also reported that: "Overall, it is concluded that public availability of performance – particularly to tenants – has a potentially positive impact on base building performance." (The Warren Centre for Advanced Engineering, 2009).

Feedback from interviews: *The most effective way to engage with the occupants of a building about energy efficiency is to show it to them. This could be simply achieved by an obvious display in the lobby showing the energy performance (compared to a target) of the base building. This concept can then be developed, with the agreement of the tenants, to show the energy performance of every floor/tenant, and encourage good behaviour. One can even imagine the FM running monthly competitions between tenants with small prizes as a reward for the winners. The cost of the prizes will be easily kept at a fraction of the savings on the energy bills!*

The Green Lease guide offers an interesting insight into the suggested collaboration (The Department of Climate Change and Energy Efficiency, 2012):

> *[…]the co-operative approach is not just taken at the initial phase of creating a green lease, it is encouraged throughout the life of the lease and thereby transforms the traditional adversarial landlord-tenant relationship into one of common vision and mutual benefit.*

The guide suggests the FM and the occupants meet frequently in "forums" where the FM reports the performance of the building, benchmarks the tenant's consumption against other similar lettable areas, and reminds them of the relation between behaviour, consumption and cost. Again, working closely with occupants can influence their behaviour to be closer to the predicted behaviour and thus close the performance gap.

Architect Mark Way, the instigator of the Soft Landings methodology, suggests the FM team should organise information meetings for users at the time of the first occupancy to present their role, how the building works and what is expected from them (Way, 2005). He adds that FM teams should make themselves approachable and easily reachable to foster best FM/occupants relations, and continues by suggesting the FM should send out a monthly newsletter with information about efforts of the FM to satisfy occupants' expectations, answers to questions from other occupants and tips on how to best "live" the building or operate the BS.

5 Facility management training and support

As Building Services are continuously becoming more efficient and adaptive, they are becoming more complex and more difficult to understand (The Carbon Trust, 2011). Therefore, there is a need for more education about energy efficiency to enable Facility Managers to better understand the systems (Ernst & Young, 2015). As the skills associated with energy efficiency are not necessarily provided in any available formal qualification, specific vocational training is required (The Warren Centre for Advanced Engineering, 2009).[2]

> **Feedback from interviews**: *Cases were mentioned where BMS were showing alarms, but the FM staff in place did not know how to interpret them or how to react.*

Nevertheless, however much FMs are trained and skilled, there are always issues born in the Design and Construction phases that will show up during the Operation phase (see the Report 3 for details on what the project team termed this "grey area"). One of the important measures to maintain the efficiency of the building and avoid a performance gap is to require the Design and the Construction teams to remain involved in the Operation phase to support the FM. Standard construction and retrofit contracts will usually mention a Defect Liability Period (DLP) of 12 months that necessarily

[2] NB: Building performance analytic software can help here too, see Section 3

goes beyond remedying the defect; thus it is important to achieve the support and involvement of these teams in reaching the performance target.

> **Feedback from interviews**: *The Design team, the Construction team and the FM team together would ideally be made contractually accountable for the first two NABERS energy ratings [i.e. 24months of occupancy]*[3]

Facility Managers also have the challenging task to please both the tenants and the building owner, each having their own perception and expectation of energy efficiency. The required training should, therefore, not only be about the technical details but also about advocacy (and communication) on energy efficiency to owners, contractors, users and other stakeholders (Sustainability Victoria, 2016). Indeed, the FM is key to influencing the behaviour of the occupants (cf section 4.2above) but also the strategic link with the owner (Curtis et al., 2017) who is expecting the building to perform as designed.

The FM is, therefore, the key person in the building to understand and drive building performance; thus the FM is the key person, in the operation phase, able to minimise the performance gap between predicted and actual. Unfortunately, training of the FM is too often left until after Practical Completion (Way, 2005).

6 Documentation

The documentation related to the Building Services and the operation of the building is not a measure in itself to minimise the performance gap. Best practises are covered here to support the other sections.

6.1 The Operation and Maintenance Manual

The O&M manual is a standard document in the building industry. It is a document created by the designer for the FM. In the present topic of retrofitted buildings, this manual would be updated with the elements of the building that have been modified and improved. This manual should be presented to the FM before the handover and represents the most important document in their training. This is not really a measure to minimise the performance gap but could not be omitted from the list of relevant documents.

[3] NB: A similar Design Team/FM collaboration is currently being applied to the new Perth Children Hospital with the NDY Building Services design team supporting the FM during the first 24 months of operation. Similarly, the WA government has developed a new contract model for the new Perth Stadium: Based on the traditional Engineer, Procure, Construct (EPC), they added Maintain (and operate) to the contract, now called EPCM.

6.2 The Building User Guide (to complement the House Rules)

As mentioned in Section 4, the behaviour of the occupants – the users of the building – may be different from what was predicted and considered in the energy simulation during the design phase. This may be because buildings have become more complex and even if the trend is to have more automation, "using" the buildings as they are intended requires some support. Most office buildings have a set of House Rules to prevent atypical occupant behaviours that could impact the intended operation of the building. The suggestion here is to add a softer document than the House Rules called a Building User Guide. While the House Rules are in the leasing contract to the attention of the tenant's management team, the Building User Guide is designed for all occupants (including the staff of the tenants). It is an invaluable solution to communicate how the building has been designed, how it is intended to work, and how to operate the local control facilities or equipment such as heating, lighting, ventilation (Way & Bordass, 2005). This is supported by Green Star[4], which rewards credits for the presence of a Building User Guide, as well as the CitySwitch program[5] which helps office-based businesses to improve their energy and waste efficiency.

6.3 The FM logbook

The Facility Manager must take the lead in monitoring energy consumption and usage (Way & Bordass, 2005). The Facility Management logbook is a simple, easily-accessible summary of a building services' controls strategy, predicted energy performance and the means to monitor it, separate to the Operation and Maintenance manual (The Carbon Trust, 2011). The *Chartered Institution of Building Services Engineers* (CIBSE) proposes a building logbook toolkit[6] that includes a useful template for developing a logbook.

6.4 Asset Register

As Building Services become more complex and controls more numerous, it will help the FM to have a record of the assets in the building with a short description mentioning location, primary functions/use and expected performance. This Asset Register will help the FM locate failed components in the building and better coordinate contractors for the resolution of the issue. The Asset Register is also useful to set a maintenance contract and ensures that all parties are aware of the equipment that must be covered in the contract (Lecamwasam et al., 2012). Ultimately, this piece of documentation will participate in reducing the period the building is not operating properly and minimising the impact of the performance.

6.5 Tenancy Fit-out Guidelines

The Tenancy Fit-out Guideline is always a good document to have ready. This document ensures tenants do not modify the building in a way that affects the intended operation of the Building Services and create a performance gap.

[4] https://new.gbca.org.au/green-star/
[5] https://cityswitch.net.au/About-Us/WhatisCitySwitch
[6] https://www.cibse.org/knowledge/knowledge-items/detail?id=a0q20000008I7eiAAC

6.6 The future of documentation

The future of documentation should be fully digital and shared, but has been affected by the (slow) uptake of BIM that can help the FM understand and better maintain and operate their building.

The future of documentation is not only digital but also integrated and multi-sourced. Göçer et al. (2015) suggest an innovative method to integrate the results of *Post-Occupancy Evaluation* (POE) in the BIM database of a building using *Geographical Information System* (GIS) technology. This method aims at making it easier to visualise the performance of a building by integrating data aggregated from POE studies.

7 Energy efficiency related tax incentives

The previous sections revealed that many operational factors that contribute to the performance gap are linked to the motivation of the building owner to close this gap and offer a more energy efficient workplace to the tenants. However, the tenants are paying the energy bills, directly and indirectly (directly for their leased area and indirectly for the base building), so the building owners are only interested in the energy performance of their building from a marketing perspective. Unfortunately, the latter can vary depending on the market situation of commercial leases in an area, as a high level of office vacancy would force more building owners to upgrade to attract or keep tenants (Ernst & Young, 2015).

> **Feedback from interviews**: *It is interesting to observe how landlords start caring about the (disclosed) energy efficiency of their building when it becomes a competitive advantage to attract tenants during economic slowdowns. This period is also the best time to implement significant HVAC and lighting upgrades when the building has vacancies (when whole floors are vacant). Unfortunately, it is also during that period that the cashflow is the lowest for the landlord.*

One strategy to alleviate this variation and to encourage building owners to care more consistently about the energy performance of their buildings is to create an economic link between energy consumption and the owner's bottom line. The tax system is a solution that many countries have used and more particularly the accelerated depreciation of capital investment in eligible replacement or upgrade of building components contributing to its energy efficiency.

7.1 Building energy efficiency related tax incentives in the USA

The US Congress passed the Internal Revenue Code Section 179D *Energy Efficient Commercial Buildings Deduction* as part of the Energy Policy Act of 2005 (U.S. government – Office of Energy Efficiency & Renewable Energy. *179D Commercial Buildings Energy Efficiency Tax Deduction*). The building must achieve a certified 50% savings in energy and power costs compared to the minimum standard in the following three categories:

- Interior lighting systems
- Heating, cooling, ventilation and hot water systems

- Building envelopes (e.g., insulation, roofing and windows)

The deduction is available to building owners and lessees who make improvements to a commercial building leading to the minimum required energy savings. As government entities do not pay tax, the owners of these buildings can allocate the deductions to the designer or builder responsible for the energy-saving enhancements, who are able to claim the deduction (Ernst & Young, 2012).

Note: The program expired in 2018 as part of the Trump administration reforms.

7.2 Building energy efficiency related tax incentives in Europe

Most countries of the EEC have also implemented tax incentives programs for energy efficient retrofit of commercial buildings (more particularly Germany and Portugal). However, in Europe, the legislative focus is rather on mandating a minimum requirement for buildings (including on the existing stock when undergoing a significant retrofit) and for the performance of appliances (the Energy Performance Certificate standard), or even banning the sale of inefficient products (e.g. incandescent light bulbs).

7.3 Building energy efficiency related tax incentives in Australia

The Gillard Labor Government sought to introduce legislation establishing a Tax Break for Green Buildings in the first half of 2011. Businesses that invest in eligible assets or capital works to improve the energy efficiency of their existing buildings – from 2 stars or lower to 4 stars or higher – were to be able to apply for a one-off bonus tax deduction of up to 50 per cent of the cost of the eligible assets or capital works. Unfortunately, the legislation was not passed and was dropped in 2012 (*The Australian Design Review,* 2012).

The research team suggests to introduce a tax incentive for energy efficient equipment in office buildings based on carbon emissions (i.e. using the NABERS Star rating) and not on energy consumption (as was done in the USA). Indeed, this would open the range of eligible options to onsite renewable energy solutions and more thoroughly contribute to the mitigation of climate change.

8 Existing frameworks developed to minimise the performance gap

8.1 History and background of the Soft Landings strategy

The Architects' Journal (Clark*, 2012*) defines Soft Landings as "*a palette of activities which improves the performance outcomes of buildings because designers and contractors remain involved with buildings after practical completion. They help fine-tune the systems and ensure occupants understand how to operate their buildings*".

The Soft Landings framework was conceived in the late 1990s by UK architect Mark Way, initially as a way to improve the transition of a building from construction into operation (Clark*, 2012*). It was further developed by industry and academia (University of Cambridge) to finally be published as an official method in 2009 by the *Building Services Research and Information Association* (BSRIA). In 2015, CIBSE ANZ officially launched the "Soft Landings Framework Australia and New Zealand," and the UK

Government made Soft Landings methodology mandatory for all government estate from 2016 onwards.

However, in Australia, this framework still does not get much traction. One interviewee explained how being innovative is often seen as being potentially time-hungry during the first implementations, and consequently is sold at a premium by EPC contractors. Conversely, building owners are not convinced of the potential savings this additional service could unlock and are not ready to pay for it.

> **Feedback from interviews**: *The Soft Landing framework must be driven by a passionate champion and not by someone looking to maximise his profit.*

8.2 Cross-check between the Soft Landings framework and the strategies identified

As explained earlier, the strategies to minimise the performance gap focusing on the operation phase take root before the operation phase. This is echoed in the Soft Landings framework, in the "pre-handover" phase where one of the targets is to ensure, before commissioning, the FM has the knowledge and the ability to maintain, control and manage the building. This target supports the strategy defined earlier in this report under FM training in Section 5.

The first phase of the Soft Landings framework is in the operation phase of the building and is called "initial aftercare"; it starts when occupants move in. As Agha-Hossein (2018) says: *"The aftercare team must be available at known times and location (in the building) to explain to the end users (the occupants) how their building works and answer questions".* This correlates with the strategy described in Section 4 about engaging and even training the occupants to ensure their behaviour is less erratic and more as predicted.

The last phase of the Soft Landings framework is called the "Extended aftercare and POE". The notion of extended aftercare was mentioned in section 3 when suggesting the need to cross-check the performance of the building in all seasons and even to recommission the sensitive weather systems in the opposite season of the year and perhaps during every season of the year.

8.3 The nDeep framework

The nDeep framework was developed in 2014 (published online in 2015) by students of Leeds University (UK) and tested on university buildings (Robinson et al., 2016).

The purpose of the nDeep framework is to define the contributory factors for the performance gap considering both the physical environment and social and cultural aspects. The two major foci of the framework are the building design and user behaviour so that the performance gap is approached with a focus on the building–user interaction unique to non-domestic buildings. It is particularly useful to understand the conflicts which emerge between meeting user needs and operating a building at maximum energy efficiency (Robinson et al., 2016). Note that the nDeep framework has yet to be implemented in office buildings.

9 Ranking the measures

While all the measures and solutions described above are pertinent to minimising the performance gap, they do not all have the same cost nor the same impact. For this study to be better communicated to the industry, the research team looked into the literature for feedback on the relative cost and impact of these measures.

In a study from The Carbon Trust (2011), about the challenges to closing the gap between design prediction and operation performance of low-carbon commercial buildings in the UK, the relative cost and impact of a variety of measures were sorted in the following matrix:

Figure 2 The relative cost and impact of a variety of measures which a client might take to deliver their low carbon buildings aspirations. Source: The Carbon Trust (2011)

The matrix points out that *seasonal commissioning* and *full facilities management training* are the measures, in the operation phase, with the best Impact/Cost ratio to ensure the energy performance target is actually delivered. Note that both these strategies involve the collaboration of teams from different phases.

Post-occupancy evaluation is found in the *Low Impact* half of the matrix, though the report mentions: *"Extremely useful, both as a method of formally reviewing the energy and carbon performance of the building, and to gauge whether employees and occupants are satisfied with the building".*[7]

The *Soft Landings* strategy is ranked as High Impact. Unfortunately, as with all strategies requiring teams involved in the project to participate longer than usual, it is also a costly process.

The *Metering* strategy involves higher-than-usual capital investment in more important metering capacity but the benefits of that investment last the whole life of the building.

[7] Note the feedback from industry professionals seems to disagree with POE being considered as a low-cost measure.

10 Proposed Closing the Gap framework

This report's suggested Closing the Gap framework is set out in the Appendix. It follows the four categories of activity set out in this report: monitoring, collaborating, training (FMs) and documenting. The Energy efficiency tax incentives factor has not been included in this framework as it has no strategy or measure that landlords can implement or improve on their own. The framework sets out the measures to use in sub-categories and makes comments on each of them. Together, the *Framework for Closing the Gap in the Building Operational Phase* provides a comprehensive and integrated approach to assist buildings achieve their expected energy efficiency after handover.

Ultimately, building owners are looking for a secure and durable return on their investment (ROI). Energy bills, client satisfaction and other post occupancy activities are only components of this ROI, and if they all participate to the success of the investment, sometimes they may do so in conflicting ways that make owning a building a risky business even with the best FM team.

However, "a tool is as good as the person using it" and in this case, all the solutions, measures, strategies or frameworks that can overcome the performance gap are useless if there isn't a change in mentality in the construction industry, accountability of the actors or maybe stricter control of compliance by the authorities. Thus, the next section in this report suggests a more structural change to closing the gap.

11 Total Facility Management contracting[8]

Contracts on buildings are based on legal requirements set in law by governments that wish to achieve a good set of outcomes. It is clear from this research that there is a constant and perhaps growing gap between design and operational outcomes in Australian buildings when it comes to energy retrofitting. Perhaps it is time to rethink these regulations and create a new kind of contract that would require a new and more complete approach to FM services. This could be called *Total Facility Management* (TFM).

TFM would be based on a business model where the building owner would be provided with the peace-of-mind of efficient building operation for a fixed fee. TFM would be an integrated service, aggregating all services linked to the operation of the building including but not limited to: building operation, maintenance, cleaning and occupant relations. For this system to work, the integrated service provider would also be responsible for paying all the bills such as energy and water. The TFM contract would also include a variable portion based on customer satisfaction or a percentage of the revenue from leases, in order to incentivise the service provider to drive the building not only to energy efficiency targets but also occupants' comfort and productivity, and ultimately make the building attractive to premium tenants.

Facility Management being already a service and not a product, the innovative shift would be from the current "action-based" contract to a performance-based contract. The TFM would draw from the *Product-Service System* (PSS) theory whose business model finds its success primarily from two components: from internal efficiency, that allows the service provider to make a profit without

[8] This section is using knowledge and findings on Product-Service Systems (PSS) from the author (Lio Hebert)'s ongoing PhD research.

increasing the total cost for the customer; and from internal synergy that allows the service provider to offer, at no additional cost, complementary services valuable to the customer, hence creating a better value proposition.

Energy-as-a-service already exists in the European and American building sector in the form of Energy Saving Performance Contracts (ESPC), though these are rarely used in Australia as there is perhaps a greater appetite to manage the risk involved in not having the predicted outcome. In the ESPC, an external service provider takes over the energy bill of the building owner in exchange for a long-term contract with fixed fees. The contractor then uses its expertise in FM and Building Services to optimise the performance of the system, reduce the energy consumption (and the energy bills) and use the savings to make a profit.

Some similar approaches have begun to appear in Australia. Facilities Management (and Property Management) company Colliers International has teamed up with Building Services Company BSA and Finance and ESPC Company EcoSave to offer the *EcoSave Service Agreement*[9] (ESA) that guarantees a 4.0-star NABERS energy rating. Effectively, this is a performance-based Facility Management service contract.

Other Australian examples include the *Green Lease*[10] which makes use of the concept of performance-based contracting, but this time between the building owner and the tenants. A clause in the Green Lease template allows for a percentage of the rent to be withheld (rent abatement) in case a gap in the performance of the building (and an increase in the energy costs of the tenant) appears. Australian companies such as EnergyTech, IBMS, Bueno Systems and GreenSense have shifted from installing meters in buildings to offering a full set of monitoring services, including the installation, calibration and maintenance of sub-meters; these deliver valuable information to the FM (and building owner) to close the performance gap or reach a higher level of NABERS rating.

However, there is no overall agreed approach to something more akin to the proposed *Total Facility Management* contracting based on performance and not just actions. These actions are listed in the Closing the Gap framework, but the TFM contract would ensure they are done. This is a disruptive approach to the current approach to FM which is essentially not working. The TFM could be designed and promoted by the Australian Sustainable Built Environment Council (ASBEC).

If this voluntary application of a TFM contract does not get taken up, then governments would need to step in and create the policies to make it happen. Thus, a set of regulations would be created that makes such *Total Facility Management* a mainstream exercise in managing buildings, including the closing of the gap for energy retrofitting. This could be done through the Council of Australian Governments (COAG) agreeing on such a strategy and enabling legislation in each State, since that is where buildings are managed.

[9] https://ecosave.com.au/energy-efficiency/ecosave-services-agreement/
[10] https://www.energy.gov.au/government-priorities/energy-productivity-and-energy-efficiency/green-leases

12 Conclusion

The literature review revealed some existing frameworks presenting strategies to minimise the performance gap, such as nDeep, and Soft Landings. However, the former focuses on user behaviour while the latter is not only about the energy performance gap but just any gap between the predicted product and the finished product.

The present report focused on the strategies for the operational staff/facilities managers to minimise the energy gap in the operation stage of retrofitted office buildings, with an additional category (on tax incentives) that opens up to a broader scope. Strategies were identified based on previous work in this project, and organised under five themes:

1. Monitoring, tracking and fine-tuning
2. Collaboration with the occupants and with the leasing agent
3. Facility management training and support
4. Documentation[11].
5. Energy efficiency related tax incentives

However, "a tool is as good as the person using it" and in this case, all the solutions, measures, strategies or frameworks that can overcome the performance gap are useless if there isn't a change in mentality in the construction industry, accountability of the actors or maybe stricter control of compliance by the authorities. The innovative *Total Facility Management* concept proposed in this report gives some ideas on how to overcome some of the barriers to minimising the performance gap, by shifting the FM contract from being action-based to performance-based. This could be introduced through a voluntary process run by ASBEC or a regulatory approach by COAG to make a more structural contribution to closing the gap.

[11] Note that Documentation acts more as a support to the other categories than a category in itself.

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Appendix: **Framework for Closing the Gap**

FRAMEWORK OF STRATEGIES AND MEASURES TO CLOSING THE PERFORMANCE GAP IN THE BUILDING OPERATION PHASE

item #	Category	Sub category	Measure	Comments
1.1	**Monitoring, tracking and fine-tuning**	Monitoring	Use software analytics	Use software analytics to complement the BMS and better understand the source of the performance gap
1.2		Tracking	Adjust the operating conditions of the reference	Adjust the operating conditions of the reference (NABERS) to better gauge the performance gap
1.3		Fine-tuning	Run secondary commissionings	Run one of several commissioning in different climate conditions (different seasons) to ensure that weather-sensitive building services (BS) are working as designed
1.4			Understand the complexity and the overall target before fine tuning	Understand the relationship between BS equipment and elements, and what is the overall target to achieve before starting fine-tuning in isolation
2.1	**Collaborating with the occupants and lease agent**	Leasing terms	Let the FM assist the leasing agent in the negotiation with tenants with atypical use of their space	Some atypical occupant behaviour or use of tenancy spaces (floor) may not be compatible with the capacity of the building services and will result in a performance gap. The facility manager (FM) should be involved in the negotiation of leases particularly when the use of tenancy spaces don't comply with the House Rules
2.2		Share the aspiration	General information meeting for the occupants	Organise a general meeting soon after the start of occupancy to sensibilise the occupants on the aspiration of the retrofit, why it is beneficial also for them and how they can play a part
2.3			Monthly FM newsletter	Send a monthly newsletter with information about efforts of the FM to satisfy occupants, answer to questions from other occupants
2.4		Inform occupants	Add signs and notes next to controls of BS	Instruct occupants on the proper operation of services can be done in person during the general meeting but is best achieved by adding signs and notes next to controls of BS
2.5			Monthly FM newsletter	The newsletter can also be useful here to give some tips on how to best operate the BS
2.6		FM/occupants relations	Invite occupants to meet him/her to discuss	Ideally, the FM would have an office in the building where occupants can meet him/her If not, the FM could organise to be onsite once a week to meet occupants in group
3.1	**FM training & support**	Technical knowledge	Involve the FM in all stages of the retrofit, from Design to commissioning	This is to give a sense of ownership to the FM and gain insights from engineers and contractors
3.2		Building Management System (BMS)	Extensive induction to Building Management System	BMS relies on meters and sensors to monitor performance and alert BS failures or BS going off-track. Knowing where are these meters and sensors and what they really tell is as important to use the BMS to its full capacity
3.3		New technologies	Upskill FM to new technologies in BS and monitoring	Building services may look the same and perform the same service, the technology behing them may have evolved. Making sure the FM has caught up with the new versions will make him/her more efficient when dealing with fine-tuning or failures
3.4		Social communication	Train up the FM advocacy and social communication skills	This is important to enable and support measures mentioned in the "Occupant Behaviour" category
3.5		Support	Support from Design and Construction teams	To help the FM understand the BS
4.1	**Documentation**	For the FM	An Operation and Maintenance Manual for the FM	Document created by the designer for the operator (the FM) This manual would cover at minimum the elements of the building that have been modified and improved
4.2			A logbook for the FM to record activities and outcomes (performance)	Besides recording the performance, the logbook is also a summary of a building services' controls strategy, predicted energy performance and the means to monitor it
4.3			Asset register	Gather useful information on BS such as short description mentioning location, primary functions/use and expected performance
4.4		For the occupants	A user manual for the occupants of the building	A document to communicate how the building has been designed, how it is intended to work, and how to operate the local control facilities for heating, lighting, ventilation, etc
4.5			A tenancy fit-out guideline	A document to ensure tenants do not modify the building in a way that affects the overall performance (or the performance of the base building)