The 'Performance Nexus' for Existing Commercial Buildings

Considering the main elements that affect the performance of commercial buildings in order to strengthen efforts to reduce fossil energy consumption and support a productive workplace

A Sustainable Built Environment National Research Centre (SBEnrc) literature review by Curtin University and the Queensland University of Technology

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CONTENTS OF WORKBOOK

Why Use the Performance Nexus?

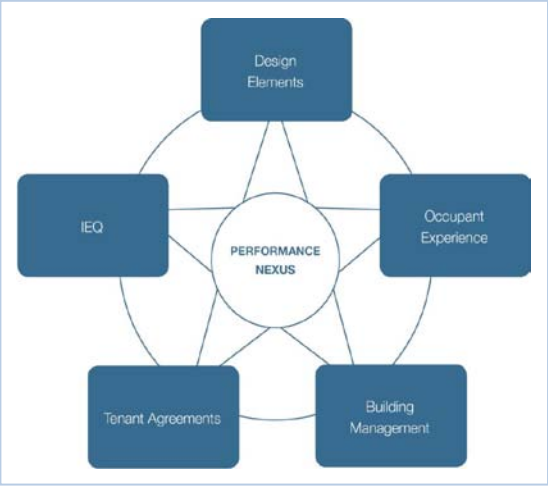
In Australia there are approximately 21 million square metres of commercial office space spread across nearly 4,000 buildings in Australian cities,[i] with low-grade office stock constituting the majority of this space in terms of net lettable area.[ii] As the energy performance of much of this low-grade stock has yet to be improved there is growing interest in cost-effective energy management options. Furthermore, tenants are increasingly demanding office space that meets high indoor environment standards as awareness of the importance of indoor environment quality in supporting greater productivity becomes more widespread.

Retrofit initiatives often focus predominantly on installing more efficient equipment, however simply installing energy efficient design elements is often not sufficient to achieve lasting energy efficiency and occupant satisfaction outcomes. Many examples can be found of efficient design elements that are poorly maintained or incorrectly operated by occupants, resulting in underperforming buildings with poor indoor environments.

In order to achieve an improvement in both energy performance and productivity a whole of building approach is needed that involves communication between the many stakeholders and sub-contractors involved in operating buildings. Such an approach challenges standard industry practices and requires a new framework that goes beyond a focus only on energy management.

The Performance Nexus presents a framework to assist efforts to improve the energy performance of existing commercial buildings while fostering a productive environment. The framework considers five nodes that should be considered when designing interventions, including design elements, building management practices, tenant agreements and communication, occupant experience, and indoor environmental quality. The Performance Nexus can be used to assess whether the correct systems are in place to support the optimal functioning of a building's design elements and help identify where relationships between nodes could be strengthened to support improved building performance.

This workbook is designed to assist efforts to improve the energy efficiency of buildings in a way that can support a productive workplace. The tool has been developed through research, stakeholder workshops, and trials with partners to identify the key metrics of a building's performance to consider when designing an intervention.



The tool uses targeted questionnaires for occupants, tenants, building managers and building owners, designed to identify key systems and practices and potential areas for improvement. It can be used to identify where these relationships can be better integrated to achieve optimal results. In the following paragraphs we highlight the objectives of questioning for each node, which have been distilled from the literature and builds on these insights regarding barriers to accessing data. The summary demonstrates the complexity of considerations when taking a holistic approach to building performance evaluation and the need for a systematic approach to inquiry to avoid missing opportunities.

Design Elements

Design elements can profoundly impact the energy consumption of a building and can impact indoor environment quality and occupant satisfaction. Design elements can also dictate what building management options are available. This node of the Nexus focuses on identifying key existing energy efficient design elements within a building and identifying retrofit technologies that could be considered. The node focuses on the following areas:

- *Monitoring and Control Technology:* To investigate the type of monitoring and control systems are suitable for the building and ensure they are tied into the reporting process. Basic metering options are available at reasonably low cost and allow building operators to manually monitor energy use for specific equipment (such as boilers and chillers) or in a defined area (such as a particular floor or tenancy). Advanced energy monitoring and control technologies offer more detailed monitoring, control and reporting options and can interface with other building systems and meters.
- *Lighting:* To investigate the type of lighting system installed and identify areas for potential improvement to technologies used. Lighting systems are made up of a number of subsystems, which contribute to the efficiency and suitability of the overall system. It is important to consider the other nodes of the 'Performance Nexus' as, for example the most energy efficient bulb will not necessarily deliver lower energy demand if the space is over-lit, if lights are left on when space not in use, and if lighting systems are poorly maintained.
- *Heating, Ventilation and Air-Conditioning:* To investigate the configuration of the current HVAC system and identify areas for potential improvement. There is an increasing expectation for HVAC systems to be energy efficient while also meeting high indoor air quality and comfort standards. Considerations include variable speed drives for pumps and fans, replacing constant air volume systems with variable air volume systems, using economy cycles when conditions are suitable, and HVAC zoning. Other initiatives such as ensuring correct equipment sizing, efficient duct design and layout, energy recovery systems, and choosing efficient equipment with a high coefficient of performance can contribute to further energy savings and ensure the system is well suited to occupant requirements.
- *Other Plant and Equipment:* To investigate if efficiency initiatives for other plant and equipment have been implemented or can be improved. Using high efficiency pumps, fans and motors with variable speed drives can deliver significant savings. Considerations include options for escalators and elevators (such as standby power, efficient control algorithms, regenerative braking systems, and alternative use of stairs), hot water systems (such as efficient fixtures), and server rooms (such as switching off unnecessary computers, reducing and consolidating equipment, and improving server environment).[iii]
- *Building Fabric:* To investigate if the building fabric can be further optimised for climatic conditions to improve occupant satisfaction. Building fabric refers to the roof, walls, and fenestration, as well as external shading features and other exterior elements. These features affect both the energy use and the physical environment inside a building. They can be linked with a number of problems associated with poor indoor environmental conditions, such as thermal comfort, poor ventilation, problem lighting and glare.
- *Tenancy Design and Fit Out:* To investigate if the design and fit out is conducive to energy efficiency and occupant satisfaction. Considerations include open plan form, surface colour, plant installations, internal blinds and partitions, individual controls over indoor environmental conditions such as temperature and lighting, providing controls in accessible locations and educating occupants on use.

Building Management

Building management practices can have a profound impact on the overall functioning of a building, ultimately impacting energy demand, indoor environment quality, and occupant experience. The management and maintenance of buildings is thus receiving more attention as a key component of building performance. This node of the Nexus considers the way design elements are used and maintained, and how information from the other nodes of the Nexus is used in decision-making processes. The node considers the following areas:

- *Operation and Management Practices:* To investigate if key operation and management practices are being used to help improve energy performance and occupant satisfaction. Considering that some of the principal sources of inefficiencies in commercial buildings are HVAC and lighting technology it makes sense to consider these areas first to identify if significant efficiencies could potentially be achieved prior to outlaying capital on major refurbishments. Considerations include aligning equipment runtimes to occupancy schedules, identifying if equipment is the right size, and whether passive design features such as operable windows and external shadings features are being used when suitable.
- *Reporting and Evaluation:* To investigate if the performance of design elements is monitored and if reporting practices are feeding into decision-making processes. Data on building performing can indicate when design elements are running unnecessarily which can amount to immediate savings. Considerations include whether key performance metrics are measured and with what frequency, and if there are any performance targets set. These can include energy targets, as well as IEQ or occupant satisfaction targets. The questioning considers whether data reporting is in an intuitive and actionable form so that it is able to influence building management decisions to facilitate good decision-making processes.
- *Maintenance and Cleaning:* To investigate if maintenance practices are conducive to energy efficient operation and improved indoor environment quality. Even the most efficient buildings will consume excess energy if they are not maintained efficiently. Considerations include the existence of planned maintenance strategies which allow for preventive rather than reactive maintenance from faults or breakdowns, the extent of maintenance documentation to ensure good knowledge transfer, previous modifications that have altered the maintenance and/or cleaning schedule, and evidence of good cleaning procedures (such as fans, dampers, condenser coils).
- *Commissioning and Tuning:* To investigate which systems within the building have undergone commissioning and what level of understanding there is on the building's history, dates of commissioning/re-commissioning and retro-commissioning. Commissioning generally takes place in the first year following the delivery of a new building, however existing buildings may undergo re-commissioning and retro-commissioning to improve performance or resolve problems that may have occurred over time. Considerations include the regularity and extent of commissioning and subsequent tuning, including a focus on lighting and HVAC, which are core sources for faults.
- *Management Personnel, Communication and Education:* To establish the key stakeholders responsible for building management and the existence of incentives and education programs to encourage improved building performance. The ownership and management structures of buildings can have a significant impact on the performance, as all stakeholders have different intentions for the space. Considerations include the existence of training for management personnel as lack of awareness and education may prohibit uptake of energy efficiency actions.
- *Procurement:* To investigate if procurement practices encourage energy efficient equipment and improved IEQ. Considerations include whether procurement practices specify that upgrades and refurbishments should meet predetermined energy efficiency requirements, which helps to guide purchasing decisions to improve energy efficiency.

Agreements and Culture

Agreements can be in two forms, namely 'hard' and 'soft'. Hard agreements include legal agreements such as green leases that affect the occupants of the buildings, which may be owner-occupiers or tenants. For instance leases may include mechanisms such as break and relocation clauses, rent and rent review clauses, and covenants to repair; all of which can be harnessed to improve building performance. Soft agreements include those related to organisational culture and communication practices that, when present, can contribute to improved building performance. This node considers the following areas:

- *Lease Agreements:* To investigate whether the terms of the lease facilitate good indoor environment quality and energy efficient operation of the building. It is important to determine the ownership and leasing structure (owner-occupied, single tenant or multiple tenancies), as different configurations govern the potential for lease agreements to be used to improve building performance. Considerations include rent and outgoings (a gross lease provides less incentive to individual tenants to improve energy performance), financial incentives, rent review clauses (which can require tenants or owners to meet certain energy efficiency targets), the term of a lease, break and relocation clauses which can facilitate environmental upgrades, and repair and alterations clauses which can allow a building owner to withhold consent for alterations that negatively impact the energy efficiency or indoor environment quality of the premises.
- *Organisational Culture:* To investigate how supportive the various building stakeholders' corporate cultures are of sustainability and energy efficiency. The way that different companies engage with energy efficiency strategies is influenced by their organisational culture. If companies are not defining environmental objectives as a corporate commitment at a management level it is unlikely energy efficiency will be seen as a priority. Considerations include how the behaviour of staff occupying a building is linked to building management processes and how this is linked to the occupying organisation's approach to communication, monitoring and evaluation.
- *Communication and Education Initiatives:* To investigate the types of communication, education and behaviour change programs in place in the building. There can be many stakeholders involved in the management and operation of a building and there can often be a breakdown in the level of communication between the parties. Considerations include the extent of communication between portfolio and building managers and along the management chain, communication between tenants and owners, the extent of meetings and participation in building management committees, where representatives meet regularly to discuss building performance, can assist communication, and documented feedback to stakeholders on building performance.
- *Ratings, Mandates and Incentives:* To investigate the type of performance tools and rating systems used in the building and access to incentive programs. There is a wide range of rating systems designed to improve the performance of new and existing buildings that can be used as a structure. Considerations include whether occupiers are demanding higher performance, requests for action on mandates and incentives, such as environmental upgrade agreements and the extent of any requests for financing to help fund environmental improvements to existing buildings.
- *Commitments and Targets:* To investigate the existence of commitments and targets related to energy and indoor environment quality performance. Considerations include the extent of targets for building performance measures such as energy, IEQ performance, or occupant satisfaction, public disclosure of goals and targets, and the existence of energy management plans. The questioning also highlights whether energy services companies have been engaged to meet targets through an energy performance contract, and whether these also focus on meeting indoor environment quality targets to ensure energy efficiency initiatives do not negatively impact occupant experience.

Indoor Environment Quality

Indoor environment quality (IEQ) can have a significant impact on occupant health and productivity. Key IEQ parameters can provide valuable guidance as to how to improve conditions as part of efforts to improve energy performance. Measurements taken in the same zones used to conduct the occupant experience survey allows correlation between occupant responses and IEQ data. This node considers the following areas:

- *Basic IEQ Monitoring:* To provide a basic level of understanding of the indoor environment and identify any potential problem areas. Considerations include a number of basic IEQ parameters (temperature, lighting levels, and carbon dioxide), using handheld equipment which can be performed by suitably trained facilities management or building management personnel, or potentially a suitable occupier representative. Handheld equipment is somewhat inaccurate, however it can prove a low cost way to help to identify potential problem areas and provide a basic level of understanding of the indoor environment when performed regularly and systematically. It is important to ensure equipment is regularly calibrated to avoid incorrect readings. Basic-level testing should be performed by building managers on a regular basis, supported by periodic advanced-level testing and where potential issues are discovered using basic-level testing.
- *Specialised IEQ Monitoring:* To establish a detailed understanding of the indoor environment, to inform commissioning or tuning activities in the building. More sophisticated measurement of IEQ parameters by environmental services contractors provides optimal outcomes for indoor environment quality and occupant satisfaction. Measured parameters may include the abovementioned factors as well as chemical and biological testing using advanced monitoring equipment and specially trained operators. Testing may be a once-off measurement or as part of a planned monitoring strategy.
- *IEQ Management Programs:* To identify the presence of a strategy for managing IEQ. This includes consideration of the extent of IEQ management programs for the building, which can provide greater certainty of measurements and results and represents a better way to manage buildings for optimal outcomes. Similarly to energy management programs, ongoing measurement and management of IEQ inside buildings beyond the usual risk assessment levels can improve overall performance.
- *Health and Well-Being:* To investigate the extent of data on health and well-being in the buildings. Although physical IEQ parameters to not directly quantify productivity, however they can account for factors which can directly impact the health, well-being, and productivity potential of building occupants. Considerations include the type and extent of health and well-being data collected (e.g. absenteeism and health costs), which can be useful to allow crosschecking with IEQ measurements. However, it can be difficult to remove planned time off in organizations that encourage the taking of sick leave. Health complaints and reported IEQ issues related to factors such as thermal comfort, visual comfort and air quality can be tracked and reviewed.
- *Reporting and Communication of Results:* To establish the extent of documentation on IEQ and how it is communicated within and beyond the building. Reporting and communicating IEQ results to key stakeholders and decision-makers can ensure maintenance practices can be improved to help achieve indoor environment and occupant satisfaction outcomes. Considerations include the extent of communication of the collected data with building owners, operation and maintenance personnel, contractors, and tenancy managers.

Occupant Experience

It is generally assumed that a relationship exists between the quality of the office environment and the health and well-being of its occupants, and numerous studies on environmental variables such as air quality and lighting confirm this link. It is also accepted that occupants who are dissatisfied with the indoor environment are more likely to say that this affects their productivity, whereas if people are comfortable they often perceive a better environment. It is therefore important to identify potential problem areas and systems that are contributing to dissatisfaction in order to rectify the situation. This node considers the following areas:

- *Perceived Productivity:* To identify potential areas and systems that are contributing to dissatisfaction in the workplace. Occupants who are dissatisfied with the indoor environmental conditions are more likely to say that this affects their productivity. Productivity is influenced by a complex interaction of physiological, psychological, social, managerial and individual factors[iv] and is thus inherently difficult to define and to measure in an office environment.[v] Therefore proxies such as perceived productivity, health complaints, and absenteeism can be used as an indication of the importance of issues related to productivity. Studies have also shown that lower job satisfaction rates are linked to higher rates of absenteeism[vi] and staff turnover.[vii] The '*Performance Nexus*' does not directly ask staff to rate their productivity, but rather how supportive the environment is for productivity.
- *Communication and Reporting:* To investigate if systems are in place to provide occupants with feedback about building operation, and identify if occupants are satisfied with how any issues related to their feedback are resolved. When occupants feel heard, and when they feel as if they have some control over their comfort, they may be more likely to be tolerant of temporary discomfort.[viii]
- *Training, Education and Guidance:* To investigate how well occupants are aware of the existence of design elements in a building that could contribute to improved satisfaction and how much they know about using individual controls. Effective training and education for occupants on energy efficient behaviour and correct operation of building elements is essential if buildings are to perform optimally. The way occupants interact within a building can have impacts at a tenancy level, but base building energy consumption can also be affected. When occupants are properly informed and engaged in building operation, low energy designs can achieve high rates of occupant satisfaction.
- *Use of Controls:* To investigate whether occupants use individual controls to modify their environment. Occupants can dramatically impact the energy performance of a building through their interaction with design elements and building operation. Controls may be available for features such as lighting systems, HVAC, external shading features, internal blinds, and power management features. There is growing evidence that some degree of individual control is important for occupant satisfaction and well-being. Perceived comfort increases when occupants have some control over their environment, and even small personal adaptive changes can greatly improve comfort.[ix]

Sample of Key Linkages for Design Elements

Monitoring and Control Technology

DESIGN ELEMENTS – Monitoring and Control Technology This node focuses on monitoring and control (M&C) technology that can facilitate high indoor environment quality and energy efficient building operation. Energy metering systems can provide insight into current energy performance and help identify where energy is being wasted and when used optimally they can help deliver energy savings of 5 – 20 per cent.[x]	
BM	Monitoring and control technology can provide building managers with the ability to track the performance of specific equipment, systems, or tenants. Advanced M&C systems provide a greater level of control and analysis of building systems and can be powerful visualisation aids to help building managers understand building performance.
AC	Energy monitoring data can be used to inform initiatives and agreements related to energy efficiency, such as Energy Management Plans and energy performance targets. Energy monitoring data can be used to determine if tenants/occupants are operating building systems and technology correctly and in accordance with lease agreements.
OE	M&C technology is typically kept hidden from occupants; however presenting performance information from these systems in a way that is intuitive can engage occupants in energy efficiency and facilitate greater understanding of building systems and functions.
IEQ	Monitoring and control technology, particularly advanced building management systems, can allow precise monitoring and control of indoor environment conditions in order to create an environment conducive to productivity.
BUILDING MANAGEMENT This node focuses on the building management practices that can be put in place to ensure monitoring and control technology is used optimally to achieve energy efficiency and occupant satisfaction outcomes. M&C technologies are important tools for improving building performance but require good building management practices to become powerful tools.	
DE	M&C technology facilitates precise control of building systems, such as HVAC and lighting. Initial commissioning and ongoing tuning of M&C technology is imperative to ensure accurate readings and correct system operation.
OE	Communicate energy monitoring data to occupants so they can become active participants in the energy efficient operation of the building. Regular feedback assists both occupants and building managers to understand performance.
IEQ	M&C technology is the often the primary means of controlling the indoor environment in a building. Regular inspection and maintenance of M&C technology will ensure controls are functioning correctly in order to maintain good IEQ.
AC	In order to get the most benefit out of the technology, use monitoring data to generate regular reports that are presented in an understandable and actionable form to key decision makers. Monitoring data can be used to formulate incentives for building management to encourage better building performance.[xi]
INDOOR ENVIRONMENT QUALITY This node focuses on the impacts of monitoring and control technology on indoor environment quality. Optimal functioning of building systems often relies on monitoring and control technology.	
DE	Indoor environment quality monitoring systems can be used to provide optimal conditions while reducing energy consumption. For example CO_2 monitoring technology can interface with air-handling systems to provide demand-controlled ventilation, ensuring good IEQ while avoiding conditioning of excess outside air.[xii]
BM	Ensure monitoring and control data is checked with IEQ measurement data in order to inform maintenance and tuning practices for M&C technology. Measured IEQ results that lie outside recommended ranges may indicate incorrect control systems operation or faulty sensors.
OE	Provide results of the Occupant Experience survey to building management personnel and other key building decision-makers as results can help identify potential problem areas.
AC	Use M&C technology in conjunction with IEQ testing to check compliance with IEQ conditions stipulated in lease documents and ensure energy efficiency measures such as Energy Performance Contracts do not negatively impact IEQ.
OCCUPANT EXPERIENCE This node focuses on occupant experience and the use of monitoring and control technology to provide feedback to building occupants about the impacts of their behaviour on building performance.	
DE	Consider providing a tenant interface to building management systems as this can provide tenants with enhanced reporting and evaluation opportunities and facilitate greater understanding of building systems.
BM	Effective communication of Use results from the Occupant Experience survey to inform maintenance and operation of M&C technology.
IEQ	Collect information from the Occupant Experience survey about IEQ complaints and occupant health to correlate with monitoring and control data.
AC	Use the Occupant Experience survey to check occupants' awareness of energy performance. Strengthening organisational culture around sustainability can assist in encouraging occupants to take ownership and more responsibility for actions that impact performance.
AGREEMENTS AND CULTURE This node focuses on using data from monitoring and control systems to inform commitments and targets and educate occupants about their impact on energy consumption. Use metering data to guide incentive programs and engage occupants in	

energy efficiency. [xiii]	
DE	Energy targets can be incorporated into lease agreements with tenants, using monitoring and control technology to inform and track progress and engage tenants in efficiency initiatives.
OE	Ensure systems are in place to communicate energy monitoring information to occupants and check the effectiveness of this communication with the Occupant Experience survey.
IEQ	Lease agreements can be used to set indoor environment conditions such as temperature for the office area and monitoring and control technology can be used to verify compliance.
BM	Monitoring and control technology can be set up to collect energy data to comply with green lease schedules or environmental reporting initiatives.

BM: Building Management DE: Design Elements OE: Occupant Experience
IEQ: Indoor environment Quality AC: Agreements and Culture

Lighting

DESIGN ELEMENTS This node focuses on the effectiveness of the lighting design as it has a major impact on occupant satisfaction and energy demand in the building. Electric lighting is a large user of energy and also generates waste heat which places additional load on building HVAC systems, estimated to account for up to 15-20 per cent of cooling demand.[xiv,xv]	
BM	Ensure lighting controls are in accessible locations with clear labelling or occupants will not use them. Consider reducing maintained artificial illuminance levels in general office areas and providing appropriate task lighting. [xvi]
AC	Consider the inclusion of specific energy and IEQ performance requirements for lighting in tenant leases. Such requirements can be supported by the provision of education on how and when to use lighting controls and how this impacts building performance.
OE	Consider the occupant experience of the level and quality of light as improved lighting can increase individual productivity though increased working speed, reduced error rate, improved concentration, and other co-benefits.[xvii]
IEQ	Check the actual lighting levels (LUX) at workstations both horizontally and vertically to assess compliance with guidelines for workstations and general areas. Supplement with task lighting where required to improve productivity.[xviii]
BUILDING MANAGEMENT This node focuses on the processes to ensure design lighting levels are maintained, as cleaning lights can improve output by as much as 25-30 percent.[xix] Further, incorrect wattage of bulbs in light fittings can negate the cost of any retrofits. Options such as group re-lamping at planned intervals can reduce labour costs to between one-fifth and one-tenth of the cost per lamp for spot re-lamping.[xx]	
DE	Ensuring high efficiency lighting is maintained with correctly matched lamps and ballasts can reduce energy consumption. Commissioning ensures correct equipment compatibility for optimal efficiency.
OE	Ensuring lighting quality is monitored and faulty lamps replaced reduces disruption to staff and avoids negative impacts on productivity and occupant experience. Appropriate lighting layout and design can reduce glare and reflections that may affect visual amenity inside the building.
IEQ	Good building management practices such as regular cleaning of lamps, luminaires and surfaces can increase light output, potentially avoiding the need for lighting retrofits or facilitating de-lamping options.[xxi]
AC	Implement policies to ensure contractors and maintenance staff are informed of correct lighting components and replacement schedules.
INDOOR ENVIRONMENT QUALITY This node focuses on the impacts of lighting design and maintenance on the quality of the indoor environment. This is important as the costs of low productivity and illness in a workplace can be 100 to 200 times the cost of energy bills,[xxii] with just a 1% productivity change in Australia equating to AUD $1.2 billion.	
DE	Encourage increased natural day-lighting over artificial lights using correct tinting on windows and external or internal shading as this reduces energy consumption.
OE	Encourage increased natural day-lighting as studies have shown that this can lead to increased worker productivity, [xxiv] reduce absenteeism, [xxv] Increased vitamin intake,[xxvi] and mood improvements. [xxvii]
BM	Ensure lights and windows are adequately maintained to maximise light levels and consistency. This can be done through schedules that can also include checks on wattage and fixture conditions.
AC	Consider policies for restricting after-hours light use, providing adequate labelling and mapping of light switches, and providing clear reporting procedures for complaints on lighting.
OCCUPANT EXPERIENCE This node seeks to identify if occupants know how to use available lighting controls including light switches, external shadings, internal blinds, and desk task lighting. As effective use of lighting controls by occupants can reduce energy consumption by more than 30 percent.[xxviii]	
DE	Consider the inclusion of occupant controls in the design as this can dramatically reduce energy demand with occupants turning off lights that are not in use and reducing lighting levels to meet task requirements. Providing some degree of control over lighting levels also has a large impact on satisfaction.
IEQ	Measure the associated lighting levels to ensure that they are within recommended task lighting requirements, as users may have differing tolerance for lighting levels that may change if they are given information as to recommended levels.
BM	Check that occupants are aware of correct communication channels to report lighting issues. Good communication with occupants and prompt response to lighting complaints and can avoid dissatisfaction and distraction.
AC	Consider policies that ensure minimum task lighting standards are met as per appropriate guidelines and design standards. Provide education to ensure occupants understand how to operate the lighting system to improved energy efficiency and individual comfort.
AGREEMENTS AND CULTURE This node investigates if the organisation considers sustainability or energy efficiency as part of their core strategy and if this focus is embedded in the culture.	

DE	Consider policies that require the use of efficient lighting technologies to ensure that replacements are in line with the design intent, such as part of 'repair and alteration' clauses in lease agreements.
OE	Building organisational culture around sustainability can assist encouraging occupants to take ownership and more responsibility for their actions which impact performance.
IEQ	Consider policies that require compliance with minimum lighting levels to ensure that appropriate lighting is provided and daylighting is harnessed where appropriate.
BM	Consider policies that set minimum requirements for maintenance schedules to ensure efficient operation of lighting, such as part of 'repair and alteration' clauses in lease agreements. Consider policies for after-hours lighting use, adequate labelling and mapping of light switches, and reporting procedures for complaints on lighting.

BM: Building Management DE: Design Elements OE: Occupant Experience
IEQ: Indoor environment Quality AC: Agreements and Culture

Heating, Ventilation and Air Conditioning

DESIGN ELEMENTS – Heating, Ventilation and Air Conditioning This node focuses on the effectiveness of the HVAC design as it has a major impact on the energy demand of the building and the satisfaction of occupants. HVAC systems may be responsible for up to 50 per cent of total energy use[xxix] and studies show building users consider thermal comfort to be amongst the most important parameter influencing overall satisfaction with IEQ.[xxx]	
BM	Improving the 'maintainability' of HVAC plant and equipment is essential to ensure building management personnel are able to deliver energy and IEQ outcomes.[xxxi] Access to plant rooms, ductwork, air-handlers and other components is imperative and good knowledge management procedures are integral to ensure optimal system performance.
AC	Implement policies that require assessment of fitout changes for their potential to impact IEQ and energy efficiency. New partitions and walls can alter ventilation patterns, and supplementary HVAC systems can work against central systems.
OE	HVAC systems are a primary determinant of occupant satisfaction, yet many offices are too cold in summer and too hot in winter. Adjusting thermostat settings by just 1°C can reduce HVAC energy consumption by six per cent and may reduce air-conditioning complaints.[xxxii]
IEQ	Poorly designed and maintained HVAC systems can detrimentally affect indoor air quality and result in illness and reduced productivity.[xxxiii]
BUILDING MANAGEMENT This node focuses on the benefits of building management practices and procedures that can enhance HVAC system and component performance. Poorly designed and maintained HVAC systems can detrimentally affect indoor air quality and result in illness and reduced productivity.[xxxiv] Finding and fixing common faults can be integrated with an ongoing building management plan and lead to 16% energy savings from commissioning existing buildings.[xxxv]	
DE	Investigate HVAC systems and components to ensure right-sized equipment with good part-load performance. Efficiency drops off rapidly for equipment loaded below 50 per cent of capacity.[xxxvi] Optimise economy cycles and night purge modes[xxxvii] and ensure HVAC zones are appropriately sized and loaded to provide energy efficient HVAC operation.
OE	Actioning occupant complaints helps to assure occupants their feedback is of value and promotes open and continuing communication.
IEQ	Good building management practices, such as regular maintenance of HVAC components, filter replacement and coil cleaning can optimise energy efficiency[xxxviii] and improve indoor environment quality.[xxxix]
AC	Maintaining offices within a narrow temperature band may consume excess energy without necessarily improving occupant comfort. Providing low-energy adaptive comfort opportunities for occupants and adjusting tenant agreements to facilitate a wider temperature band can provide comfort benefits, often achieved in naturally ventilated buildings.[xl]
INDOOR ENVIRONMENT QUALITY This node focuses on IEQ parameters that are influenced by HVAC systems and how integration with other nodes can facilitate improved building performance.	
DE	IEQ parameters such as temperature, relative humidity, air velocity, and carbon dioxide should be regularly measured to indicate if HVAC systems are providing optimum conditions for occupant comfort. Actively use IEQ results to help identify if other design elements may be impacting IEQ (for example building fabric, glazing, or shading elements).
OE	Temperature has a direct impact on the satisfaction and productivity of occupants; however the ideal temperature can vary between individuals and groups depending on preference and activity. Providing temperature control of ±2°C may increase work performance by 3-7 per cent and could be achieved with energy-efficient desk-mounted devices.[xli]
BM	Poorly maintained HVAC systems are common and are associated with increased prevalence of building-related illness.[xlii] Implement an IEQ management program incorporating ongoing professional IEQ monitoring and physical inspection of HCAV equipment and ensure results inform building management practices to facilitate continual IEQ improvement.
AC	Tenant agreements and fit out guidelines can set out requirements for IEQ testing before and after any fit out works to prevent negative impacts on IEQ and ensure that tenants and contractors are made aware of their responsibilities.
OCCUPANT EXPERIENCE This node focuses on the occupant experience as a result of HVAC system performance. Understanding the experience of occupants can help identify potential problem areas, inform building management practices, and guide initiatives to improve energy and IEQ performance.	
DE	Use the occupant experience survey to assess whether occupants are aware of HVAC controls and other design elements such as operable windows, blinds, shading elements, or vents that can impact energy efficiency and thermal comfort.
IEQ	Conduct a regular occupant experience survey to check thermal comfort and satisfaction with air quality and compare results against IEQ measurements to identify potential problem areas.
BM	Measuring air quality (carbon dioxide, carbon monoxide, particulate matter, VOC.s Formaldehyde) can show levels of toxins and air quality inside buildings that are impacting the health of occupants. Air flow and ventilation rates are important to ensure adequate levels of fresh air are entering the building.
AC	Provide education on low-energy comfort options available to occupants and consider implementing a clothing policy that allows staff to adjust clothing choices to suit ambient conditions.

AGREEMENTS AND CULTURE This node focuses on how lease arrangements and office culture can impact building performance through interactions with heating, ventilation and air-conditioning systems.	
DE	Repair and alterations clauses can allow a building owner to withhold consent for alterations that negatively impact the energy efficiency or indoor environment quality of the premises. Energy performance of tenants or of building systems can also be considered in rent and rent review clauses to encourage energy efficient HVAC design and operation.
OE	Actively using results of the occupant experience survey to identify issues and respond to occupant needs will improve health and productivity. Occupants are less susceptible to environmental stressors when well-being needs, such as sensory variability and supportive workplace cultures, are met.[xliii]
IEQ	Fit out guidelines can specify materials and equipment requirements for tenancy and base buildings areas to ensure IEQ performance is not compromised. Tenant agreements can be used to enforce compliance,.
BM	Tenant agreements and good communication between building stakeholders can assist with aligning HVAC plant operating schedules to occupancy hours to ensure equipment is only operated when required.

BM: Building Management DE: Design Elements OE: Occupant Experience
IEQ: Indoor environment Quality AC: Agreements and Culture

Building Fabric

DESIGN ELEMENTS – Building Fabric Consider the whole system impacts of fabric upgrades as they can result in improved indoor environment quality, drastically reduced cooling loads, better utilisation of daylight, and improved radiant comfort. [xliv]	
BM	The type of building fabric design elements that the building has will have an impact on building management tasks and requirements, for example operable windows or external shading may create additional maintenance requirements.
OE	Operable design elements can contribute significantly to occupant satisfaction or dissatisfaction. Studies show that occupants with some degree of control over conditions are more satisfied. External shading features can be automated or manually controlled to reduce heat gain and control lighting.
IEQ	Glazing can impact lighting levels and lighting quality. Use of external shading features reduces solar gain, which has significant impacts on energy efficiency of HVAC systems and thermal comfort of occupants.
AC	Educate occupants on their ability to significantly impact energy efficiency and comfort using operable building fabric design elements. Effective daylighting strategies may require occupants to correctly use shading or blinds to optimise lighting conditions, but can help deliver reductions in annual lighting energy consumption by 10 – 60 per cent. [xlv]
BUILDING MANAGEMENT Good building management practices help to ensure the building fabric is functioning optimally for energy efficiency and occupant comfort outcomes.	
DE	Maintenance of operable design elements such as windows, louvers, and external shading elements is important to ensure they function correctly. Inspection of fabric elements such as insulation and window seals is important to ensure they are in good working order. Consider improving the reflectivity of the external building fabric to reduce solar gain.
OE	Implementing passive energy efficiency strategies (such as insulating external walls and altering the reflectivity of the building fabric so that it is optimised for the climate) can help reduce solar heat gain and better control daylighting which can help to improve comfort conditions for occupants.
IEQ	Good building management practices help to ensure the building fabric contributes positively to indoor environment quality. Check building tightness and existence of thermal bridging as this may have IEQ impacts. Green walls and green roofs can help reduce solar gain and can contribute to improved thermal comfort.
AC	Building management personnel should educate occupants about correct and energy efficient use of building fabric design elements, and how this can contribute to reduced energy consumption and improved comfort.
INDOOR ENVIRONMENT QUALITY IEQ monitoring can be used to inform building management practices and help identify if building fabric design elements are contributing to good building energy and comfort performance.	
DE	IEQ measurements can be used to evaluate if improved building fabric design elements should be considered. For example, if IEQ results indicate elevated temperatures in perimeter zones it may help to investigate if improved glazing or external shading features could reduce temperatures by controlling solar gain.
OE	Communicating results of IEQ measurements to occupants can help them understand how building fabric design elements can contribute to energy efficiency and improved comfort. For example if operable louvers or windows are incorrectly used they may negatively impact on thermal conditions or air movement.
BM	Results from IEQ measurement can be used to inform maintenance and operation of building fabric design elements. Regular monitoring allows greater understanding of how a particular building functions and can help identify any potential issues.
AC	Use IEQ monitoring in collaboration with tenant agreements to influence occupant behaviour. For example, natural ventilation strategies may specify a temperature range within which it is prohibited to operate mechanical cooling equipment; IEQ monitoring can inform occupants of real-time temperatures and when mechanical cooling is prohibited.
OCCUPANT EXPERIENCE This node explores whether the Occupant Experience survey can be used to determine if occupants are satisfied with internal conditions that may be influenced by the building fabric, and to determine occupants' knowledge of any operable building fabric design elements that may be available to them.	
DE	Check awareness and use of operable building fabric design features through the Occupant Experience survey. For example, correct use of operable windows and external shading features may contribute to energy efficient building operation when implemented as part of a ventilation strategy.
IEQ	Result of the Occupant Experience survey can help identify if building fabric design elements may be compromising indoor environment quality, leading to occupant dissatisfaction.
BM	Use results from the Occupant Experience survey to inform maintenance and operation of building fabric design elements.
AC	A building cannot operate efficiently without informed and educated occupants. The Occupant Experience survey can be used to check occupants' awareness and knowledge of building fabric design elements that can contribute to improved energy efficiency or occupant comfort.
AGREEMENTS AND CULTURE This node focuses on using agreement and culture initiatives such as education and communication	

DE	Tenant agreements can stipulate how design elements are to be used, and provide guidance on correct operation as per a building users' guide.
OE	Good communication with occupants and education of how building fabric elements can contribute to energy efficiency outcomes can result in better-informed tenants who may take more initiative to use building features to improve their personal comfort.
BM	Good communication from building management regarding building fabric design elements that can be used by occupants to improve energy efficiency or comfort is integral.

BM: Building Management DE: Design Elements OE: Occupant Experience
IEQ: Indoor environment Quality AC: Agreements and Culture

Other Plant and Equipment

DESIGN ELEMENTS This node focuses on energy consumption from other plant and equipment, including elevators, lifts, domestic hot water systems, servers, and other components such as pumps and motors. Collectively, these systems and equipment can contribute substantially to energy consumption.	
BM	Consider plant and equipment options that improve energy efficiency while reducing building management requirements. Variable speed drives can reduce energy consumption by 50 per cent[xlvi] and can improve system reliability by reducing wear,[xlvii] resulting in reduced maintenance requirements.
IEQ	Other building plant and equipment, such as pumps, fans and motors can impact IEQ through interaction with other building systems and components and impacting performance of equipment such as chillers and other HVAC plant.
OE	Check satisfaction with maintenance issues and effectiveness of communication between occupants and other stakeholders to ensure occupant dissatisfaction caused by building mechanical systems is dealt with quickly
AC	Make stairwells accessible and keep them well-maintained to encourage occupants to use them (especially for short journeys) to reduce elevator starts and energy use while contributing to improved occupant health.[xlviii]
BUILDING MANAGEMENT This node focuses on building management practices that can improve the performance of other plant and equipment to contribute to energy efficiency outcomes.	
DE	Efficiency measures can reduce elevator energy use by 30-40 per cent.[xlix] Investigate options to improve efficiency, such as through reduced stand-by power using efficient lighting and elevator plant room ventilation systems and equipment, and implementing optimised control algorithms and regenerative braking.[l]
OE	Use occupant experience surveys to create or check effectiveness of education programs. Investigating behaviours such as water efficiency to reduce hot water energy use, and using stairs for short journeys to reduce elevator use.
IEQ	Maintaining up-to-date manuals and maintenance documentation for plant and equipment can assist building managers to quickly identify and repair building systems to optimise building performance and reduce impacts on IEQ.
AC	Implement procurement policies that specify minimum energy efficiency performance for new plant and equipment. Procurement policies can ensure efficient equipment is given preference, particularly during emergency replacement.
INDOOR ENVIRONMENT QUALITY This node focuses on the impacts of plant and equipment on indoor environment quality. Monitoring and maintaining mechanical systems can improve IEQ.	
OE	Mechanical systems and components, such as pumps, fans, motors and server room equipment, can contribute to acoustic and vibration issues that may impact occupant experience if not appropriately identified and managed.
DE	Maintaining and re-commissioning ancillary fans and equipment can reduce energy demand and improve indoor environment quality.
BM	Regular maintenance and cleaning of pumps, motors and fans can improve IEQ through reduced noise and vibration. Regular inspection and preventive maintenance can ensure properly aligned coupling, sufficient bearing lubrication, proper belt tension, and validate optimum functioning.
AC	Consider base building energy targets and performance incentives for building management personnel to increase awareness of efficiency opportunities available through improvements to other plant and equipment.
OCCUPANT EXPERIENCE This node seeks to understand the experience of occupants to draw out user feedback to help improve building performance.	
DE	Occupant behavior can impact other plant and equipment, for example server rooms use a considerable amount of energy and require continuous climate control, accounting for 5 – 40 per cent of energy consumption in buildings. Engaging occupants to turn off computers when not in use reduces server requests and cuts energy use.
IEQ	Use the occupant experience survey to determine if mechanical noise from mechanical systems is impacting indoor environment quality and detracting from occupants' ability to work productively.
BM	Occupant experience evaluations can provide feedback to building managers that can help identify issues. Occupants spend all day in the office and can be a reliable source of information on problems and issues.
AC	Commitments and targets can be used to help reduce energy consumption of other plant and equipment. For example, engage occupants in water efficiency targets, such as targeting a NABERS Water Rating, to help reduce water consumption and energy used to heat domestic hot water in the building.
AGREEMENTS AND CULTURE This node focuses on agreements and culture that can assist energy efficiency improvements to building plant and equipment and contribute to whole of building efficiency gains.	
DE	Agreements such as Energy Performance Contracts can be an effective means of identifying other plant and equipment upgrades that can improve whole building performance.
OE	Consider renewable energy systems, which can reduce energy usage while raising sustainability awareness and engaging occupants in an energy efficient culture of the building.
IEQ	Agreements and initiatives focussed solely on energy efficiency may impact IEQ and occupant experience if not appropriately considered. Ensure Energy Performance Contracts or similar efficiency contracts uphold high levels of

	service and meet IEQ or occupant satisfaction targets.
BM	Education initiatives for building and facilities managers can improve awareness of efficiency opportunities that can reduce energy consumption of plant and equipment, and which may have compounding efficiency benefits for other building systems.

Tenancy Design and Fit Out

DESIGN ELEMENTS – Tenancy Design and Fit Out Office design and fit out can impact occupant satisfaction and energy efficiency. Office equipment can account for 20 per cent of total energy consumption.[li] Installing efficient equipment and enabling power management strategies can reduce energy use significantly.	
BM	Tenancy fit out design can impact base building performance and building management decisions, for example equipment that produces waste heat which must then be cooled by central HVAC. Specify fit out works meet specified energy efficiency or IEQ performance requirements and communicate with occupants about the impact of their actions on tenancy and base building energy use.
OE	Tenancy fitout decisions can impact lighting, ventilation, air quality, and acoustics. Poor acoustics can be a key issue for discontent office staff [lii,liii,liv] and studies show open plan spaces are often correlated with dissatisfaction due to acoustic and distraction issues.[lv] Provide meeting rooms and social spaces in accessible areas away from occupant workstations.
IEQ	Tenancy design and fitout can increase daylight penetration to allow reduced artificial lighting levels, but may have negative occupant satisfaction impacts due to visual comfort if not well controlled. Reflectance values for floors (20-40%), walls (50-70%), ceilings (>80%), and furniture (25-45%) can help maximise daylighting.[lvi]
AC	Tenancy energy performance can be considered in rent and rent review clauses to encourage selection of more efficient office equipment. Low- and no-cost strategies can reduce plug load by 19 - 40 per cent.[lvii] This may require engagement of occupants in energy efficiency initiatives.[lviii]
BUILDING MANAGEMENT Building management practices can contribute to the optimal functioning of tenancy and common areas that can impact energy efficiency and occupant comfort outcomes.	
DE	Good maintenance of fit out design elements such as blinds, plants, office furnishings and equipment will help to ensure that they do not negatively impact energy efficiency or indoor environment quality.
OE	Regular communication between tenants, building management and owners about maintenance requests and issues can improve occupant satisfaction. Occupants may be more tolerant of temporary sub-optimal conditions if they understand why it is happening and what is being done about it.
IEQ	Tenancy fit out decisions can impact both tenancy and base building indoor environment quality, such as from poor management of dust and pollutants during fit out works. Ensure contractors and maintenance staff are aware of their responsibilities and ability to contribute to maintaining high indoor environment quality.
AC	Organise office cleaning schedules in line with operating hours to reduce energy consumption outside of normal occupancy hours and specify 'green' products for cleaning and maintenance to reduce the impact on IEQ.
INDOOR ENVIRONMENT QUALITY This node focuses on the interaction between tenancy design and fit out choices on indoor environment quality**.**	
DE	Monitor results of IEQ testing to ensure tenancy fit outs do not compromise indoor environment quality, for example through changes to tenancy plan form, occupant density or equipment plug load. Some indoor plant species can remove pollutants from indoor air[lix] and may induce positive emotional states and improved cognitive performance[lx]
OE	Tenancy fitout materials and equipment can emit volatile organic compounds and other pollutants that can impact the health and well-being of occupants. Monitor complaints related to IEQ and track health indicators such as unplanned leave or sick days.
BM	IEQ results should be used to inform management decisions, such as placement of partitions and design of the office area, as these can impact the air flow and acoustics. Consider setting IEQ targets for building or facilities managers to incentivise good practices.
AC	Incorporate indoor environment quality performance criteria into fit out design and equipment selection. Investigate Rating tools such as NABERS IE for the tenancy area to help achieve improved indoor environment quality.
OCCUPANT EXPERIENCE This node focuses on the interactions between tenancy design and fit out elements on the occupant experience, and using occupant experience surveys to inform optimal tenancy design and fitout operation.	
DE	Occupant-adjustable internal blinds can reduce energy consumption if they are suitably designed to have low solar absorption on the outward-facing side and reduced emissivity on the inward-facing side[lxi] and can reduce lighting energy by up to 50 per cent when occupants actively adjust blinds and lights to suit their preference.[lxii] Additionally, they may help control glare.[lxiii]
IEQ	An Occupant Experience survey can be compared with IEQ measurements to identify potential issues related to indoor environment. Ensure zones are designated for the survey to allow identification of problem areas.
BM	Use results of the Occupant Experience survey can help identify any potential issues with the tenancy space that may be resolved through improved building management practices.
AC	Requiring tenancy fit out changes to be approved prior to any works commencing can help to ensure IEQ occupant satisfaction are not negatively impacted. Consider results of the Occupant Experience survey to assess whether past fit out changes have reduced available light.
AGREEMENTS AND CULTURE This node focuses on the impacts of agreements and culture on tenancy design and fit out as these can be used to guide fitout	

decisions and operation strategies.	
DE	Tenant agreements such as repair and alterations clauses can be used to guide tenancy fit out decisions, ensuring equipment and materials don't negatively impact energy performance or IEQ. Consider policies on the use of low VOC materials, or mandating efficient equipment with power management options to reduce energy use significantly.
OE	Engaging occupant in targets and commitments can increase awareness and ownership of energy efficiency initiatives and improve understanding of how occupants influence tenancy energy use. Check effectiveness of strategies with the occupant experience survey.
IEQ	Repair and alterations clauses may allow a lessor to provide consent to make alterations only if these alterations maintain or improve the energy or IEQ performance, ensuring tenants are mindful of how fitouts may impact building and tenancy performance, indoor environment quality and occupant comfort.
BM	Increasing the transparency of building performance, through good communication and organisational culture, can help improve building management practices and lead to more engaged and competent operators.

BM: Building Management DE: Design Elements OE: Occupant Experience
IEQ: Indoor environment Quality AC: Agreements and Culture

The Performance Nexus Survey Tool

Overview

This workbook is written as an attachment to the Sustainable Built Environment National Research centre Industry report following the 'Design and Performance Assessment of Commercial Buildings' project. The report explains the development of the nexus and how this can be applied to existing commercial buildings.

Before commencing this workbook please ensure that you have engaged with the building manager, building owner, property managers, tenants and staff. A logistics meeting with all key stakeholders is essential prior to commencing any data collection. After the meeting a date can be set to commence data collection.

The questionnaires are divided into base building and tenancy levels. The tenancy level questions are not applicable for owner-occupied buildings. It is recommended for multi-tenanted buildings that at least one tenancy completes the survey, or a property manager for the building who is familiar with the tenancy operations.

The 'Design Elements', 'Building Management' and 'Agreements and Culture' questionnaires are designed to be handed to the key stakeholders, typically it will be the building managers and owner who will need to complete these.

The 'Occupant Experience' questionnaire can be distributed to occupants via online survey tools or as a hardcopy. Inform occupants of the purpose of the survey with an email or briefing session. Ideally, establish zones for the survey based on mechanical engineering plans and lining up seating areas in accordance with the ventilation zones. Inform occupants of the zone they are in with an information sheet on their desk.

The 'Indoor Environment Quality' data can be collected at a basic or advanced level. Basic level measurements may be useful to provide an indication of potential issues and may be undertaken by a suitably qualified representative, such as the facilities manager. For a more comprehensive and reliable assessment of IEQ it is recommended a professional assessment be undertaken by an indoor environment specialist. The NABERS IE protocol can be followed for collecting this information (www.nabers.com.au).

When all data is collected a designated contact will need to assess the information and design relevant interventions to assist with improving the performance of buildings.

What you will need:

- Handheld indoor environment quality measurement equipment
- Engineering plans of the building to establish zones for the questioning
- Online access for the occupant questionnaire
- Observation sheets for collecting indoor environment information
- A designated contact to collate all information
- A logistics meeting with all stakeholders
    - Date:
    - Personnel attending:

Building Profile

Building name:	
Address and post code:	
Year of construction:	
PCA Grade:	
Levels (#)	
Basements levels (#)	
Gross building area (m^2)	
Total net lettable area (m^2 NLA)	
Tenancy (m2 NLA)	
External landscaped area (m^2)	
Car parks (external) #	
Car parks (basement) #	
Non office areas such as retail and main business activity (e.g. takeaway food) (m^2 NLA)	
Electricity Tariff	
Electricity consumption – Base Building (kWh/annum)	
Electricity consumption – Tenancies (kWh/annum)	
Gas consumption – Base Building (kWh/annum)	
Gas consumption – Tenancies (kWh/annum)	
Other energy/ fuel (MJ/per annum)	
Number of FTEs in building (approx.)	
Typical hours of operation (Base Building)	
Typical hours of operation (Tenancies)	
Predominant window type:	
Predominant exterior wall type:	
Predominant roof type:	

CONTACT INFORMATION

Building owner(s):	
Tenant(s):	
Building/ facility manager:	
Company and contact details:	
Building owner contact person:	
Company and contact details:	
Tenant contact person:	
Company and contact details:	

Node 1: Design Elements

Design Elements: Base Building Level Questionnaire

AUDIENCE: Building Manager

1. Monitoring and Control Technology

1.1. Does the base building have basic energy metering systems?

1.1.1. Sub-metering - Are base building systems sub-metered?

	Yes	No
Cooling Systems		
Heating systems		
Pumps and fans		
Common area and external lighting		
Lifts		
Server rooms		

1.2. Does the base building have advanced energy monitoring and control systems?

1.2.1. Energy Monitoring and Control System (EMCS) / Building Management System (BMS)

	Yes	No
Time clock		
Basic EMCS/BMS System (pneumatic/electric)		
High level EMCS/BMS System (direct digital controls)		

1.2.2. Does the EMCS/BMS interface with:

	Yes	No
Chillers		
Boilers		
Thermostats		
Meters		
Zone Controls		
Lighting controls		
Lifts		
Domestic hot water systems		

1.3. Does the base building have IEQ monitoring and control technology?

- Temperature monitoring/data logging
- Carbon dioxide monitoring system

2. Lighting

2.1. Does the base building have efficient lights? (Note approximate percentage)

	Common areas	Stairwells	Elevators	Car parks, plant room etc	External lighting
	Approx. %	**Approx. %**	**Approx. %**	**Approx. %**	**Approx. %**
Incandescent					
T12					
T8					
T5					
LED					
Light pipes/tubes					
Other					

2.2. Does the base building have efficient ballasts?

	Yes	No
Low-loss magnetic ballasts		
Electronic ballasts		
Dimmable magnetic or electronic ballasts		

2.3. Does the base building have zoned lighting?

	Yes	No
Common areas		
Tenancy areas		

2.4. Does the base building have lighting controls?

	Common areas	Stairwells, bathrooms	Elevators	Car parks etc
	Approx. %	**Approx. %**	**Approx. %**	**Approx. %**
Manual switches				
Occupancy/motion sensors				
Photosensors				
Dual technology sensors				
Electronic timers/schedule control				

3. Heating Ventilation and Air Conditioning (HVAC)

3.1. Type of Cooling technology

	Age of Equipment	Coefficient of Performance	Part-load performance
Air Cooled Direct Expansion System			
Water Cooled Direct Expansion System (w/ cooling tower)			
Air Cooled Water Chiller System			
Water Cooled Water Chiller System (w/cooling tower)			
Other			

3.2. Type of Heating technology

	Age of Equipment	Rated efficiency	Part-load performance
Fan Coil System			
Gas Boiler			
Electric Boiler			
Co- or Tri-generation System			
Other			

3.3. Type of ventilation system

	Age of Equipment	Last refurbishment
Mechanical ventilation		
Mixed mode ventilation		
Natural ventilation		

3.4. Type of air handling technology

	Age of Equipment	Last refurbishment
Constant Air Volume Air Handing Unit		
Variable Air Volume Air Handing Unit		
Hybrid Air Handing System		

3.5. Does the building have efficient car park ventilation systems?

	Yes	No
Contaminant sensing systems for control of air handling technology		
Motion sensors for control of air handling technology		

3.6. Does the building have the following HVAC energy demand reduction technologies/systems?

	Yes	No
Economy cycle/economizers		
Night purging system		
Variable Speed Drives/Variable Frequency Drives		
Energy/heat recovery systems/ERV Energy recovery ventilation		
Insulation on ductwork and air-handlers?		

3.7. Does the building have HVAC zoning?

	Yes	No
Zoning - Multiple floors		
Zoning - Single floor		
Zoning - Single floor with separate perimeter and internal zones		

4. Other Plant and Equipment

4.1. Does the building have efficient vertical transport systems?

	Yes	No
Stairs		
Elevators - High efficiency motors		
Elevators - Variable frequency drives		
Elevators - Regenerative braking		
Elevators - Optimised lift controls		

4.2. Domestic hot water

4.2.1. Is the domestic hot water system energy efficient?

	Yes	No
Heat pump		
Solar hot water		
Use of waste heat for domestic hot water		
Insulated pipes to reduce heat loss		

4.3. Does the building have an efficient data centre/server?

4.3.1. Is there supplementary HVAC system for data centre?

Yes ☐ No ☐

4.4. Does the building have renewable energy systems?

	Yes	No
Solar thermal systems		
Solar photovoltaic systems		
Wind turbines		
Geothermal systems		

4.5. Does the building have energy efficient pumps, fans and motors

	Yes	No
Appropriate size / matched to output		
Variable speed drives / variable frequency drives		

5. Building Fabric

5.1. Is the building fabric optimized for the climate?

5.1.1. Does the building envelope optimise and control solar gain?

	Yes	No
Light colours to reduce solar heat gain where required (cool roof/wall with high solar reflective coating)		
Dark colours to utilize solar heat gain where required		
Green roof		
External green wall		

5.1.2. Does the building have insulation

	Yes	No
Walls		
Roof		
Ceiling		

5.1.3. Does the building have energy efficient windows?

	Yes	No
Double or triple glazing		
Low-e coatings		
Minimised thermal bridging		
Openable/operable windows		
Window and door seals in good condition		

5.1.4. Does the building have external shading features?

	Yes	No
Fixed external shading features (fins, overhangs, eaves, trees)		
Operable external shading features (louvers, external blinds)		

6. Base building and common area design

6.1. Does the base building and common area design enhance daylight penetration?

	Yes	No
Light-coloured internal wall and ceiling colour		
Light-coloured floor coverings		
Light-coloured furnishings		

6.2. Does common area fit out facilitate good indoor environment quality?

	Yes	No
Low- or no-VOC materials and furnishings		
Low- or no-formaldehyde materials and furnishings		
Green wall with appropriate species		
Potted plants with appropriate species		

6.3. Does the building facilitate active occupants?

	Yes	No
Cycling facilities		
Gym		

Design Elements: Tenancy Level Questionnaire

Audience: Tenant Representative

1. Tenancy: Monitoring and Control Technology

1.1. Does the tenancy have basic energy information/metering systems?

1.1.1. Sub-metering - Are tenant services sub-metered?

	Yes	No
Whole tenancy energy		
Lighting		
HVAC		
Plug loads		
Servers		

1.2. Does the tenancy have advanced energy monitoring and control technology?

1.2.1. Does the tenancy have energy control system/s

	Yes	No
Lighting controls		
HVAC controls		
Plug load controls		
Connection to a central Building Management System interface		

2. Tenancy: Lighting

2.1. Does the tenancy have efficient lights?

	General Tenancy Areas	Private Offices	Meeting Rooms	Kitchen, Bathrooms etc
	Approx. %	Approx. %	Approx. %	Approx. %
Incandescent				
T12				
T8				
T5				
LED				
Light pipes/tubes				
Other				

2.2. Does the tenancy have efficient ballasts?

	Yes	No
Low-loss magnetic ballasts		
Electronic ballasts		
Dimmable magnetic or electronic ballasts		

2.3. Does the tenancy have zoned lighting?

	Yes	No
< 100m^2		
> 100m^2		

2.4. Do tenancy spaces have lighting controls?

	General tenancy areas	Meeting rooms	Bathrooms	Server rooms
	Approx. %	Approx. %	Approx. %	Approx. %
Manual switches				
Occupancy/motion sensors				
Photosensors				
Dual technology sensors				
Electronic timers/schedule control				

2.5. Does the tenancy have task lighting?

Yes ☐ No ☐

3. Tenancy: Heating Ventilation and Air Conditioning

3.1. Does the tenancy have supplementary heating and cooling systems?

	Yes	No
Supplementary room air-conditioning units		
Permanent heaters		
Portable heaters		
Ceiling fans		
Portable fans		
Adjustable air vents		
Operable windows		
Doors to exterior space		

3.2. Does the tenancy have HVAC Controls

3.2.1. Temperature controls

	Yes	No
Tenancy thermostat controls		
Centrally-controlled HVAC set points		

3.2.2. Schedule controls

	Yes	No
Schedule control (set time schedule)		
Time switch		
Afterhours requests		

3.3. Does the tenancy have zoned HVAC

	Yes	No
Zoning - Multiple floors		
Zoning - Single floor		
Zoning - Single floor with separate perimeter and internal zones		

4. Tenancy: Other Plant and Equipment

4.1. Vertical transport systems

4.1.1. Does the tenancy have access to stairs for movement between floors

Yes ☐ No ☐

4.2. Domestic hot water

4.2.1. Does the tenancy have water-efficient fixtures to reduce hot water use

Yes ☐ No ☐

4.3. Does the tenancy have an efficient data centre/server?

	Yes	No
Energy efficient server equipment		
Minimisation of heat gain in server room		
Efficient cooling and ventilation system for data centres		

5. Tenancy: Building Fabric

5.1. Does the tenancy have openable/operable windows?

Yes ☐ No ☐

5.2. Can the tenancy have controls for external shading features?

Yes ☐ No ☐

6. Tenancy - Office and workstation design

6.1. Office layout

6.1.1. What is the tenancy plan form?

	Approximate percentage
Open plan	
Low cubicles	
High cubicles	
Private office	

6.2. Office equipment

6.2.1. Are tenancy equipment/plug loads as per design intent?

Yes ☐ No ☐

6.2.2. Does the tenancy have energy efficient office equipment?

	Yes	No
ENERGYSTAR Computers		
ENERGYSTAR Monitors		
ENERGYSTAR Printers		
ENERGYSTAR Kitchen appliances		

6.2.3. What is the ratio of desktop computers to printers?

	Tick
<8:1	
<14:1	
<20:1	
>20:1	

6.3. Office design

6.3.1. Does the office design and layout enhance daylight penetration?

	Yes	No
Light-coloured internal wall		
Light-coloured ceiling		
Light-coloured floor coverings		
Light-coloured furnishings (desks/partitions)		
Operable internal blinds		

6.3.2. Does the tenancy fit out facilitate good indoor environment quality?

	Yes	No
Low- or no-VOC materials and furnishings		
Low- or no-formaldehyde materials and furnishings		
Green wall with appropriate species		
Potted plants with appropriate species		

Node 2: Building Management

Building Management: Base Building Level Questionnaire

Audience: Building Manager.

Section A: General whole-building questions

1. Building Commissioning

1.1. Has the whole building been commissioned?

Yes ☐ No ☐

Date of last commissioning:	Tick
Under 1 year ago	
1-5 years ago	
6-10 years ago	
10+	

2. General Maintenance/office cleaning

2.1. Is there a maintenance schedule that is followed for the building?

Yes ☐ No ☐

2.2. What proportion of maintenance spending is preventative (e.g. replacing old HVAC units) verses corrective (e.g. fixing already failed systems)?

Maintenance expenditure	Percentage
Preventative	
Corrective	

2.3. Are office cleaning schedules in line with building operating hours?

Yes ☐ No ☐

3. Procurement

3.1. Are there any energy efficiency requirements for new or replacement equipment?

Yes ☐ No ☐

3.2. Are green products used in maintenance? (e.g. low toxin paints)

Yes ☐ No ☐

3.3. Are green products used in cleaning? (e.g. low toxin cleaners)

Yes ☐ No ☐

3.4. Are suppliers of products or services to the building required to meet any minimum environmental performance standards?

Yes ☐ No ☐

4. Management Personnel, communication and education

4.1. Are the following management and maintenance personnel used for the building?

	On-site, Off-site, Contracted externally
Individual building manager	
Building management team	
Individual facility manager	
Facility management team	
Maintenance personnel	

4.2. Is there a building management committee for the building?

Yes ☐ No ☐

4.3. Do management personnel participate in meetings with other building stakeholders?

Yes ☐ No ☐

4.4. Are there any incentives in place for the building or facility manager regarding building performance? (e.g. energy efficiency, occupant satisfaction targets).

Yes ☐ No ☐

4.5. As building manager, have you received any training in energy efficiency operation for your building?

Yes ☐ No ☐

4.6. Do the following education programs or materials exist for the building?

	Yes	**No**
Education program for building or facilities management personnel		
Education program for maintenance personnel		
Building user training program for tenants		
Building user or management manuals (base building)		
Building user or management manuals (tenancy)		

4.7. Do you feel as building manager you are able to actively effect change in regards to energy efficiency?

Yes ☐ No ☐

Section B: Design Element operation and management

1. Monitoring and control systems

1.1. Monitoring and control systems - Operation and management

1.1.1. Is data from the monitoring and control systems available in an intuitive and actionable form?

Yes ☐ No ☐

1.1.2. Is this data collected and used to manage the building?

Yes ☐ No ☐

1.2. Monitoring and control systems – Evaluation and reporting

1.2.1. Are the following measured, how frequently and are performance targets set?

Area measured (BB = Base Building)	**Measured? Yes/No**	**Frequency? Daily/Weekly/Monthly/Yearly**	**Target set? Yes/No**
BB HVAC Energy			
BB Lighting Energy			
BB Services Energy			
BB Other Energy			
Tenancy Energy			
Relative humidity			
Temperature			
Light quality			
Noise levels			
Complaints			

1.2.2. Is this data reported to key decision makers?

Yes ☐ No ☐

1.2.3. Does this data influence building management decisions?

	Yes	**No**
Energy consumption data		
Indoor environment quality data (temperature, RH, Light, Noise)		
Occupant complaints (formal tenant feedback mechanisms)		

1.3. Monitoring and control systems - Maintenance

1.3.1. Is there a planned maintenance strategy for costs associated with maintaining BMS/EMCS and IEQ systems?

Yes ☐ No ☐

1.3.2. Do you use a manufacturer's maintenance manual for the BMS/EMCS and IEQ systems?

Yes ☐ No ☐

1.3.3. Is there comprehensive and up-to-date maintenance documentation for the BMS/EMCS and IEQ systems?

Yes ☐ No ☐

1.3.4. Is the BMS or EMCS checked and maintained against actual occupancy patterns in the building?

Yes ☐ No ☐

1.4. Monitoring and control systems – Commissioning

1.4.1. Have the monitoring and control systems been commissioned

Yes ☐ No ☐

Date of last commissioning:	Tick
Under 1 year ago	
1-5 years ago	
6-10 years ago	
10+	

2. Lighting

2.1. Lighting Operation and management

2.1.1. Have any of the following high performance measures for lighting been implemented?

	Yes	No
Is lighting matched to building occupancy hours?		
Lighting levels matched to Australian standards?		

2.2. Lighting Maintenance and cleaning

2.2.1. Is there a planned maintenance strategy for costs associated with maintaining energy efficient lighting?

Yes ☐ No ☐

2.2.2. Are lights replaced when broken or are group re-lamping schedules in place?

Broken ☐ Group schedule ☐

2.2.3. Do you have a manufacturer's maintenance manual for lighting with a lighting inventory that shows details such as manufacturers, fixture type, model number and wattage?

Yes ☐ No ☐

2.2.4. Are lights accessible for maintenance?

Yes ☐ No ☐

2.2.5. Do you conduct the following processes during maintenance on lighting?

	Yes/No	Freq
Verify that the lamps are correct wattage and type		
Clean lights and fittings (including diffuser)		
Verify lighting controls are calibrated and functional - Automatic dimming controls - Occupancy sensors - Photosensors - Timers		
Verify lighting sensors are working		
Check external lights are working		
Fix light flickering		

2.3. Lighting Commissioning

2.3.1. Have lighting systems been commissioned?

Date of last commissioning:	Tick
Under 1 year ago	
1-5 years ago	
6-10 years ago	
10+	

3. Heating, Ventilation and Air-Conditioning (HVAC)

3.1. HVAC Operation and management

3.1.1. What is the average set point (°C) in the following areas?

Area	Summer	Winter
Common/lobby areas		
Tenancies		
Server rooms		
Stairwells/bathrooms/other		

3.1.2. Is the system correctly sized? Does the HVAC run fully loaded for less than 10 days per year?

Yes ☐ No ☐

3.1.3. Have any of the following HVAC performance measures been implemented?

High performance measures of HVAC	Yes	No
Is economy cycle used when outdoor temperature permits?		
Are start-up and shut-down times in line with occupancy hours		
Is night purging used?		
Is natural ventilation used where possible (openable windows)		
Is simultaneous heating and cooling avoided? (e.g. chillers and boilers not running at same time)		
Cooling/ventilation of lift motor rooms not excessive or running when building unoccupied		
Ventilation of car park not excessive or running when building unoccupied		
Thermostats located in places where air flow is constant temperature and unrestricted (ie. Near return air ducts)		
Are air intakes located away from pollution sources?		
Are after hours		

3.2. HVAC Maintenance and cleaning

3.2.1. Is there a planned maintenance strategy for costs associated with maintaining HVAC systems?

Yes ☐ No ☐

3.2.2. Do you use a manufacturer's maintenance manual for the HVAC?

Yes ☐ No ☐

3.2.3. Is there comprehensive and up-to-date maintenance documentation for the HVAC?

Yes ☐ No ☐

3.2.4. Are the following systems and areas accessible for routine maintenance?

Area	Yes	No
Mechanical equipment		
Rooftop		
Ductwork		
Air handler		
Filters		
Fan coil units		

3.2.5. Do you conduct the following cleaning procedures and how frequently is this performed?

Process	Yes/No	Freq
Cleaning HVAC fans, bearings, belts and air ducts		
Filter replacement		
Cleaning evaporator and condenser coils		
Inspect, fixing and cleaning leaks in air ducts		
Clean and adjust dampers		
Clean boilers		

3.3. HVAC Commissioning

3.3.1. Has the HVAC been commissioned?

Yes ☐ No ☐

Date of last commissioning:	Tick
Under 1 year ago	
1-5 years ago	
6-10 years ago	
10+	

3.3.2. Do you experience any of the following?

Process and action on faults	Yes	No	Not sure
Duct or valve leakage			
Airflow not balanced			
Improper refrigerant charge			
Dampers not working properly			
Problems with hardware installation			
Software programming errors			
Air-cooled condenser fouling			

4. Other plant and equipment

4.1. Elevators - Operation and management

4.1.1. Are elevator control algorithms optimised for energy efficiency?

Yes ☐ No ☐

4.2. Elevators - Maintenance and cleaning

4.2.1. Is there a planned maintenance strategy for costs associated with maintaining elevators?

Yes ☐ No ☐

4.2.2. Do you use a manufacturer's maintenance manual for the maintaining elevators?

Yes ☐ No ☐

4.2.3. Is there comprehensive and up-to-date maintenance documentation for the elevator systems?

Yes ☐ No ☐

4.3. Elevators - Commissioning

4.3.1. Have the elevator systems been commissioned?

Yes ☐ No ☐

Date of last commissioning:	Tick
Under 1 year ago	
1-5 years ago	
6-10 years ago	
10+	

4.4. Domestic hot water - Operation and management

4.4.1. Are domestic hot water temperature settings higher than required by Australian Standards?

Yes ☐ No ☐

4.5. Domestic hot water - Maintenance and cleaning

4.5.1. Is there a planned maintenance strategy for costs associated with maintaining domestic hot water systems?

Yes ☐ No ☐

4.5.2. Do you use a manufacturer's maintenance manual for the maintaining domestic hot water systems?

Yes ☐ No ☐

4.5.3. Is there comprehensive and up-to-date maintenance documentation for the domestic hot water systems?

Yes ☐ No ☐

4.6. Domestic hot water - Commissioning

4.6.1. Have the domestic hot water systems been commissioned?

Yes ☐ No ☐

Date of last commissioning:	Tick
Under 1 year ago	
1-5 years ago	
6-10 years ago	
10+	

4.7. Renewable energy systems - Operation and management

4.7.1. Are any renewable energy systems operational and connected to the building's electricity supply?

Yes ☐ No ☐

4.8. Renewable energy systems - Maintenance and cleaning

4.8.1. Is there a planned maintenance strategy for costs associated with maintaining renewable systems?

Yes ☐ No ☐

4.8.2. Do you use a manufacturer's maintenance manual for the maintaining renewable systems?

Yes ☐ No ☐

4.8.3. Is there comprehensive and up-to-date maintenance documentation for the renewable systems?

Yes ☐ No ☐

4.9. Renewable energy systems - Commissioning

4.9.1. Have the renewable energy systems been commissioned?

Yes ☐ No ☐

Date of last commissioning:	Tick
Under 1 year ago	
1-5 years ago	
6-10 years ago	
10+	

4.10. Pumps, fans and motors – Operation and Management

4.10.1. Have the following energy efficiency measures been implemented?

	Yes	No
Turn off/sequence unnecessary pumps/fans/motors		
All bearings lubricated as per manufacturer recommendations		
Correct alignment of pump/motor coupling		
Secure pump/motor mountings are dynamically balanced		
Adjust drive belt tension to recommended specifications		
Balance three-phase power		

4.11. Pumps, fans and motors – Maintenance and Cleaning

4.11.1. Is there a planned maintenance strategy for costs associated with maintaining elevators?

Yes ☐ No ☐

4.12. Pumps, fans and motors – Commissioning

4.12.1. Have pumps, fans and motors been commissioned?

Yes ☐ No ☐

Date of last commissioning:	Tick
Under 1 year ago	
1-5 years ago	
6-10 years ago	
10+	

5. Building Fabric

5.1. Building Fabric - Operation and management

5.1.1. Are external shading features actively used to manage daylight and heat gain?

Yes ☐ No ☐

5.1.2. Are windows actively opened where appropriate to maximise natural ventilation?

Yes ☐ No ☐

5.2. Building Fabric - Maintenance and Cleaning

5.2.1. Is there a planned maintenance strategy for costs associated with maintaining the building envelope?

Yes ☐ No ☐

5.2.2. Is there comprehensive and up-to-date maintenance documentation for the building envelope?

Yes ☐ No ☐

5.2.3. Are the following areas accessible for maintenance and cleaning?

	Yes	No
Exterior of building/ facade		
Exterior windows/ glazing		

5.2.4. Do you encounter issues with any of the following when maintaining the building:

	Yes	No
Leaks from water penetrating the building		
Standing water building up around air handling units or air intake		
Cracks in the building		
Cladding or façade damage/ decay		
Mould or funghi		

5.3. Building Fabric - Commissioning

5.3.1. Has the building fabric been commissioned?

Yes ☐ No ☐

Date of last commissioning:	Tick
Under 1 year ago	
1-5 years ago	
6-10 years ago	
10+	

Building Management: Tenancy Level Questionnaire

Audience: Building Manager or Property Manager at Tenancy Level.

Section A: General whole building questions

1. Building Commissioning

1.1. Has the whole building been commissioned?

Yes ☐ No ☐

Date of last commissioning:	Tick
Under 1 year ago	
1-5 years ago	
6-10 years ago	
10+	

2. General Maintenance/office cleaning

2.1. Is there a maintenance schedule that is followed for the building?

Yes ☐ No ☐

2.2. What proportion of maintenance spending is preventative (e.g. replacing old HVAC units) verses corrective (e.g. fixing already failed systems)?

Maintenance expenditure	Percentage
Preventative	
Corrective	

2.3. Are office cleaning schedules in line with building operating hours?

Yes ☐ No ☐

3. Procurement

3.1. Are there any energy efficiency requirements for new or replacement equipment?

Yes ☐ No ☐

3.2. Are green products used in maintenance? (e.g. low toxin paints)

Yes ☐ No ☐

3.3. Are green products used in cleaning? (e.g. low toxin cleaners)

Yes ☐ No ☐

3.4. Are suppliers of products or services to the building required to meet any minimum environmental performance standards?

Yes ☐ No ☐

4. Management Personnel, communication and education

4.1. Are the following management and maintenance personnel used for the building?

	On-site, Off-site, Contracted externally
Individual building manager	
Building management team	
Individual facility manager	
Facility management team	
Maintenance personnel	

4.2. Are there any incentives in place for the building or facility manager regarding building performance? (e.g. energy efficiency, occupant satisfaction targets)

Yes ☐ No ☐

4.3. As building manager, do you have a required energy reduction target?

Yes ☐ No ☐

4.4. As building manager, do you have required indoor environment targets (e.g. occupant complaints, air quality levels etc)

Yes ☐ No ☐

4.5. Do you feel as building manager you are able to actively effect change in regards to energy efficiency?

Yes ☐ No ☐

4.6. Is there a building management committee for the building?

Yes ☐ No ☐

4.7. Do management personnel participate in meetings with other building stakeholders?

Yes ☐ No ☐

4.8. Do the following education programs or materials exist for the building?

	Yes	**No**
Education program for building or facilities management personnel		
Education program for maintenance personnel		
Building user training program for tenants		
Building user or management manuals (base building)		
Building user or management manuals (tenancy)		

Section B: Design Element operation and management

1. Monitoring and control systems

1.1. Monitoring and control systems - Operation and management

1.1.1. Do you measure and record the follow data (or are you provided with this data from the building owner/manager) and at what frequency is it recorded?

Area measured	Measured? Yes/No	Frequency? Hourly/ Daily/Weekly/Monthly/Yearly
Whole Tenancy Energy		
Tenancy Lighting		
Tenancy Plug load		
Relative humidity		
Temperature		
Light quality		
Noise levels		
Occupant complaints		

1.1.2. Is the energy data in an intuitive and actionable form?

Yes ☐ No ☐

1.1.3. Is the IEQ data available an intuitive and actionable form?

Yes ☐ No ☐

1.1.4. Does this data influence the way you operate your tenancy?

	Yes	No
Energy consumption data		
Indoor environment quality data (temperature, RH, Light, Noise)		
Occupant complaints (formal tenant feedback mechanisms)		

2. Lighting

2.1. Lighting Operation and management

2.1.1. Have any of the following performance measures for lighting been implemented?

	Yes	No
Are lights switched off when people leave the building?		
A policy or guide for lighting use?		
Maps or signage on lighting controls?		

3. Heating, Ventilation and Air-Conditioning (HVAC)

3.1. HVAC Operation and management

3.1.1. What is the average set point (°C) in your tenancy? (This may be stipulated in your lease)

Area	**Summer**	**Winter**
Tenancies		

3.1.2. Are openable windows and vents maintained for use by occupants? (e.g. can windows be opened or are they broken/blocked?)

Yes ☐ No ☐

Node 3: Agreements and Culture

Agreements and Culture: Base Building Level Questionnaire

Audience: Building Owner

1. Lease Agreements

1.1. What is the ownership and leasing structure in the building?

	Tick
Owner occupied	
Landlord/owner w/ Single tenant	
Landlord/owner w/ Multiple tenants	

1.2. Does the term of the lease encourage upgrades for energy efficiency?

	Tick
Under 1 year	
1-5 years	
6-10 years	
+ 10 years	

1.3. Energy related outgoings

1.3.1. How are outgoings determined for tenants?

	Tick
Set figure monthly	
Sub-meter reading of actual use (kWh)	
Proportion of utility bill ($)	

1.3.2. How are outgoings paid by tenants?

	Tick
Paid by tenant (net lease)	
Paid by owner and on-charged (gross lease)	
Paid by owner as part of lease (gross lease)	

1.4. Are afterhours requests charged at a premium?

	Yes	No
Lighting		
HVAC		

1.5. Rent and Review

1.5.1. Is base building energy performance considered in rent and review clauses for tenant leases?

Yes ☐ No ☐

1.5.2. Is tenancy energy performance considered in rent and review clauses for tenant leases?

Yes ☐ No ☐

1.6. Repair and Alterations (covenant to repair)

1.6.1. Does covenant to repair allow provisions for lessor to upgrade for energy efficiency?

Yes ☐ No ☐

1.6.2. Does the owner/lessor have the authority to refuse consent if alterations negatively impact the energy performance of the building?

Yes ☐ No ☐

1.6.3. Is tenant required to demonstrate that fit out will not negatively impact HVAC performance and IEQ?

Yes ☐ No ☐

1.6.4. Does the lease require tenants to seek approval for supplementary HVAC systems?

Yes ☐ No ☐

1.6.5. Is replacement material for repairs in the base building or tenancies required to meet any minimum standards (e.g. Low flow tap fixtures)?

Yes ☐ No ☐

1.7. Break and relocation

1.7.1. Is there a break and relocation clause that allows for environmental upgrades?

Yes ☐ No ☐

2. Organisational Culture and Building Culture

2.1. Does the building owner/organisation have a corporate commitment to sustainability?

Yes ☐ No ☐

2.2. Is the owner's organization active in any of the following?

Initiative	Tick
CitySwitch	
Carbon Disclosure Project	
ISO 14001	
Other	

2.3. Does the owner's organisation have an *active* sustainability team?

Yes ☐ No ☐

2.4. Does the owner's organisation have a carbon management plan? (e.g. carbon neutral plan)

Yes ☐ No ☐

2.5. Does the owner's organisation actively encourage tenants organizations to participate in sustainability initiatives?

Yes ☐ No ☐

2.6. As building owner/landlord, what are your priorities in this building? (Please order 1-5 with 5 being the highest priority)

Initiative	Order of priority
Minimising operational cost	
Energy efficiency	
Tenant satisfaction/retention	
Leasing revenue	
Indoor environment quality (e.g. Air quality)	
Other?	

2.7. Does the owner encourage alternative transport in order for building occupants to reduce car use?

Yes ☐ No ☐

2.8. Are there amenities for cyclists in the building (storage, change rooms etc)

Yes ☐ No ☐

2.9. Are there dedicated spots in the car park for car pooling/sharing?

Yes ☐ No ☐

3. Communication and Education

3.1. Is there a Building Management Committee that the building owner/landlord participates in?

Yes ☐ No ☐

3.2. Do you receive reports on building performance?

Reports	Yes	No
Energy – Base Building		
Energy – Tenancy level		
Indoor Environment Quality		
Occupant complaints		
Other		

3.2.1. Do you communicate this information to other stakeholders?

Yes ☐ No ☐

3.2.2. Is this report publicly disclosed?

Yes ☐ No ☐

3.3. How do you communicate with the following stakeholders in the building? Please indicate relevant stakeholders and how you meet with them.

Stakeholder	The building has this stakeholder Yes/No/NA	Meeting Type			
		Regular organised meeting	Meeting on request	When there's a problem	No direct communi-cation
Building or facility manager					
Tenants					
Building services contractor					
Cleaning contractor					
Maintenance contractors/team					
Leasing agents/ property managers					
Light contractor					
HVAC contractor					
OH&S					
Other					

3.4. Is there a tenant fit out guide that addresses sustainability or energy efficiency?

Yes ☐ No ☐

3.5. Is there any type of introductory and ongoing sustainability/energy efficiency education for tenants that covers the following:

	Initial	Ongoing
Use of monitoring and control systems		
Use of lighting		
Use of HVAC controls		
Use of external shading		

3.6. Is there any training and education in place for staff of the owner organization on sustainability? This is not referring to tenants in the building but staff involved (such as property management, building management, leasing agents etc)

Yes ☐ No ☐

3.7. Do you monitor complaints from the following areas within the building, and do you use this feedback to action change in the building?

	Monitored	Actioned
Monitoring & Control (e.g. access to submetres, energy use amount)		
Lighting		
Temperature		
Plant and equipment (e.g. lifts)		
Fabric (e.g. broken window seals)		

4. Ratings, Mandates, and Incentives

4.1. Does the building have any of the following?

Rating	Yes	No	Don't know	Date obtained
NABERS Energy (Base building)				
NABERS Energy (Whole building)				
NABERS IE (Base building)				
NABERS IE (Whole building)				
Green Star				
Building Energy Efficiency Certificate				

4.2. Have the owner applied for or received any incentives for building upgrades to improve energy efficiency?

Other	Yes	No
Tax breaks		
Energy efficiency upgrade grants		
Environmental Upgrade Agreement		
Government energy efficiency grants		
On-bill finance		
Low Carbon Australia loans or assistance		
Other		

4.3. Does the owner offer any incentives to tenants to improve energy efficiency at a tenancy level? (such as lighting upgrades)

Yes ☐ No ☐

4.4. Does the owner offer any incentives to tenants to improve indoor environment quality at a tenancy level?

Yes ☐ No ☐

5. Commitments and Targets

5.1. Has a base building energy baseline been established?

Other	Yes	No
Electricity (MJ/month)		
Gas (MJ/Month)		

5.2. Does the building have targets in place for any of the following and are these monitored?

Other	Targets?	Monitored?
Energy reduction targets		
Occupant satisfaction or complaint reduction targets		
IEQ targets (e.g. minimum air quality)		
Other?		

5.3. Is there an Energy Management Plan in place for the building?

Yes ☐ No ☐

5.4. Is this plan being actively followed?

Yes ☐ No ☐

5.5. Is the building under an energy performance contract, and if so, does this EPC consider IEQ?

Yes ☐ No ☐

5.6. Is there a whole building IEQ management plan for the building?

Yes ☐ No ☐

5.7. What do you perceive as the main barriers to energy efficiency in your building?

Other	Yes	No
Return on investment for upgrades		
Downtime for tenants		
Upfront costs too high		
Limited time to focus on energy efficiency		
Not a priority		
Unsure of options to make building more efficient		
Other		

5.8. What do you perceive as the main barriers for improving the indoor environment quality in your building

Agreements and Culture: Tenancy Level Questionnaire

Audience: Tenant Representative.

1. Lease Agreements

1.1. What is the ownership and leasing structure in the building?

	Yes	No
Owner occupied		
Landlord/owner w/ Single tenant		
Landlord/owner w/ Multiple tenants		

1.2. Does the term of the lease encourage energy efficiency?

	Yes	No
Under 1 year		
1-5 years		
6-10 years		
+ 10 years		

1.3. Energy related outgoings

1.3.1. How are outgoings determined for tenants?

	Yes	No
Set figure monthly		
Sub-meter reading of actual use (kWh)		
Proportion of utility bill ($)		

1.3.2. How are outgoings paid by tenants?

	Yes	No
Paid by tenant (net lease)		
Paid by owner and on-charged (gross lease)		
Paid by owner as part of lease (gross lease)		

1.3.3. Are afterhours requests charged at a premium?

	Yes	No
Lighting		
HVAC		

1.4. Rent and Review

1.4.1. Is there an energy performance target in the lease for your tenancy?

Yes ☐ No ☐

1.4.2. Is your energy performance considered in a rent and review clauses for the lease?

Yes ☐ No ☐

1.5. Repair and Alterations (covenant to repair)

1.5.1. Are tenants required to reinstate premises to former condition on departure?

Yes ☐ No ☐

1.5.2. Does covenant to repair allow provisions for tenant to upgrade for energy efficiency?

Yes ☐ No ☐

1.5.3. Is replacement material for repairs or fit-out in the tenancy required to meet any minimum standards (ie. Low flow tap fixtures)?

Yes ☐ No ☐

1.6. Break and relocation

1.6.1. Is there a break and relocation clause that allows for environmental upgrades?

Yes ☐ No ☐

2. Organisational Culture

2.1. Does the tenant organisation have a corporate commitment to sustainability?

Yes ☐ No ☐

2.2. Is the tenant organization active in any of the following?

	Tick
CitySwitch	
Carbon Disclosure Project	
ISO 14001	
Other	

2.3. Does the tenancy organization have an active sustainability team or green committee?

Yes ☐ No ☐

2.4. Does the tenancy organisation have a Carbon Management Plan? (e.g. carbon neutral plan)

Yes ☐ No ☐

2.5. Does the tenancy organisation actively encourage staff to participate in sustainability initiatives?

Yes ☐ No ☐

2.6. As tenant what are your priorities in this building? (Please order 1-5 with 5 being the highest priority)

	Order of priority
Reducing tenancy operational cost	
Energy efficiency (e.g. energy targets/carbon reductions)	
Minimising staff overheads	
Staff retention/satisfaction	
Maintaining indoor environment quality (e.g. air quality)	
Other	

2.7. Does the tenancy organisation encourage alternative transport in order for staff to reduce car use?

Yes ☐ No ☐

2.8. Are there amenities for cyclists available for staff in the building (storage, change rooms etc)

Yes ☐ No ☐

3. Communication and Education

3.1. How do you communicate with the following stakeholders in the building?

Stakeholder	The building has this stakeholder Yes/No/NA	Meeting Type			
		Regular organised meeting	Meeting on request	When there's a problem	No direct communi-cation
Building or facility manager					
Other tenants					
Building services contractor					
Cleaning contractor					
Maintenance contractors/team					
Leasing agents/ property managers					
Lighting contractor					
HVAC contractor					
OH&S					
Other					

3.2. Is there a Building Management Committee that the tenancy organisation participates in?

Yes ☐ No ☐

3.3. Are stakeholders easily approachable to discuss building related issues?

	Tick
Very approachable	
Somewhat approachable	
Difficult to approach	

3.4. Do you receive reports on building performance?

	Yes	No
Energy – Base Building		
Energy – Tenancy level		
Indoor Environment Quality		
Occupant complaints		
Other		

3.5. Are you provided with any fit out guidelines or advice that addresses sustainability or energy efficiency?

Yes ☐ No ☐

3.6. Is there any type of ongoing sustainability/energy efficiency education for tenants? (e.g. use stairs instead of elevators)

Yes ☐ No ☐

4. Ratings, Mandates, and Incentives

4.1. Does your tenancy have any of the following Ratings?

Rating	Yes	No	Don't know	Date obtained
NABERS Energy				
NABERS IEQ				
Green Star				

4.2. Has the tenancy undergone retrofits or upgrades to be more sustainable?

Yes ☐ No ☐

4.3. Have any incentives for upgrades been obtained?

	Yes	No
Tax breaks		
Energy efficiency upgrade grants		
Environmental Upgrade Agreement		
Government energy efficiency grants		
On-bill finance		
Low Carbon Australia loans or assistance		
Other		

5. Commitments and Targets

5.1. Has a tenancy energy baseline been established?

	Yes	No
Electricity (MJ/month)		
Gas (MJ/Month)		

5.2. Has the tenancy organization been involved with the development of an Energy Management Plan for the building?

Yes ☐ No ☐

5.3. What do you perceive as the main barriers to energy efficiency in your tenancy?

	Yes	No
Return on investment for upgrades		
Downtime/ inconvenience		
Upfront costs too high		
Limited time to focus on energy efficiency		
Not a priority		
Unsure of options to make tenancy more efficient		
Other		

5.4. Does the tenancy use GreenPower?

Yes ☐ No ☐

5.5. Does the tenancy have targets in place for any of the following and are these monitored?

	Targets?	Monitored?
Energy reduction targets		
Occupant satisfaction or complaint reduction targets		
IEQ targets (e.g. minimum air quality)		
Other? ##		

Node 4: Indoor Environment Quality

Indoor Environment Quality: Base Building Level Questionnaire

Audience: Building Manager

1. Basic IEQ Monitoring

1.1. Are the following indoor environment quality parameters measured for the base building?

	Never	Once off	Daily	Weekly	Monthly	Yearly
Temperature						
Relative humidity						
Air movement						
Light						
Sound levels						
Carbon dioxide						

2. Advanced IEQ monitoring

2.1. Does the base building contract an indoor environment specialist to measure the following indoor environment quality parameters?

	Never	Once off	Daily	Weekly	Monthly	Yearly
Temperature						
Relative humidity						
Air movement						
Light						
Sound levels						
Carbon dioxide						
Carbon Monoxide						
Particulate Matter						
VOC						
Formaldehyde						
Microbials						

3. IEQ Management Program

3.1. Is there an indoor air quality management plan for the base building?

Yes ☐ No ☐

4. Health and well-being

4.1. Does the base building monitor complaints related to IEQ

	Yes	No
Temperature		
Lighting		
Noise		
Air quality		

5. Reporting and communication

5.1. Are IEQ results communicated to building stakeholders?

	Yes	No
Building owner		
Building manager		
Facilities manager		
Manager of tenancy space		

5.2. Is this information used as feedback for decisions regarding the indoor environment?

Yes ☐ No ☐

Indoor Environment Quality: Tenancy Level Questionnaire

Audience: Tenant Representative.

1. Basic IEQ Monitoring

1.1. Does the tenancy measure indoor environment quality parameters?

	Never	Once off	Daily	Weekly	Monthly	Yearly
Temperature						
Relative humidity						
Air movement						
Light						
Sound						
Carbon dioxide						

2. Advanced IEQ monitoring

2.1. Does the tenancy contract an indoor environment specialist to measure indoor environment quality parameters?

	Never	Once off	Daily	Weekly	Monthly	Yearly
Temperature						
Relative humidity						
Air movement						
Light						
Sound						
Carbon dioxide						
Carbon Monoxide						
Particulate Matter						
VOC						
Formaldehyde						
Microbials						

3. IEQ Management Program

3.1. Is there an indoor air quality management plan for the tenancy?

Yes ☐ No ☐

4. Health and well-being

4.1. Does the tenancy monitor complaints related to IEQ

	Yes	No
Temperature		
Lighting		
Noise		
Air quality		

4.2. Does the tenancy monitor indicators of health and well being?

	Yes	No
Staff sick days		
Key performance indicators		
Health complaints		

5. Reporting and communication

5.1. Are results communicated to building stakeholders?

	Yes	No
Building owner		
Building manager		
Facilities manager		
Manager of tenancy space		

5.2. Is this information actively used to influence and inform decisions regarding the indoor environment in the building?

Yes ☐ No ☐

Node 5: Occupant Experience

Occupant Experience: Tenancy Level Questionnaire

Audience: Building Occupants

1. Basic Information

1.1. Which floor do you work on?

	Tick
Level 1	
Level 2	
Level 3	
Level 4	

1.2. Which zone do you work in? (A map of the zones has been provided with the information sheet, if you are unsure please ask a member of the team).

	Tick
Zone A	
Zone B	
Zone C	
Zone D	

1.3. What age bracket do you fall into?

	Tick
30 or under	
31-40	
41-50	
>50	

1.4. What is your gender?

	Tick
Male	
Female	

1.5. How long have you been with your current employer or government department?

	Tick
Under 1 year	
1-5 years	
6-10 years	
11-15 years	
16 years and over	

2. Office design and workstation

2.1. What type of workspace do you have?

	Tick
Private office with glass/transparent walls	
Private office without glass/transparent walls	
Shared enclosed office	
Open plan with partitions you cannot see over when sitting	
Open plan with partitions you can see over when sitting	
Open plan with no partitions	
Other (please specify)	

2.2. Please rate your satisfaction with the following in your work area.

	Tick
Visual privacy at workstation	
Sound privacy at workstation	
General noise levels in office	
Daylight levels at workstation	
Greenery (plants) in the general office area	

2.3. Do any of the following regularly detract from your ability to work productively? Please check all that apply.

	Tick
Conversational noise (i.e. talking, phone calls)	
Mechanical noise (i.e. air conditioner, lifts)	
Office equipment noise (i.e. printers)	
Noise from open areas (i.e. meeting rooms)	
Outdoor noise	
Other (please specify)	

2.4. Have you received any training, education or guidance on energy efficient operation of office equipment?

	Tick
Yes	
No	

2.5. Do you have energy efficiency or power management options enabled on your computer and monitor? (e.g. sleep mode, shut down after inactive period).

	Tick
Yes	
no	
not sure	

2.6. Do you completely shut down the following at the end of day?

	Always	Sometimes	Rarely	Never
Computer				
Monitor				

2.7. Are there any other important issues regarding your workstation or office area that affect your work?

3. Thermal comfort and air quality

3.1. In general, how satisfied are you with the following?

	Very satisfied	Satisfied	Neutral	Unsatisfied	Very unsatisfied
Thermal comfort					
Air quality					
Ability to control thermal comfort					

3.2. In general, how do you rate temperature in the workplace?

	Often too cold	Comfortable	Often too hot
In summer			
In winter			

3.3. Have you received any training, education or guidance on energy efficiency in the following areas?

	Tick
Low energy options for better thermal comfort	
After hours operation of air conditioning	

3.4. Do you use any of the following to control your individual thermal comfort? Please check all that apply.

	Tick
Thermostat adjustment	
Window blinds	
Openable windows	
Portable fans	
Ceiling fans	
Dress accordingly (i.e. no ties in summer)	
Other (please specify)	

3.5. How do you report any problems with the temperature?

	Tick
Contact the building manager	
Lodge complaint online	
Tell my manager	
I don't usually tell anyone	
Other (please specify)	

3.6. How satisfied are you with response to temperature related complaints?

	Very satisfied	Satisfied	Neutral	Unsatisfied	Very unsatisfied
Level of satisfaction					

3.7. Do any of the following regularly impact from your ability to work productively? Please check all that apply.

	Tick
Inconsistency with temperature	
Uncomfortable drafts	
Uncomfortable humidity	
Unpleasant odours (from kitchen area or food)	
Unpleasant odours (from printers/ equipment)	
Unpleasant odours (from other chemicals such as finishings or furnishings)	
Poor air quality	

3.8. Do you regularly suffer from any of the following?

	Tick
Cough	
Cold and flu	
Headaches	
Sore/dry eyes	
Asthma	
Allergies irritated at work	
Other (please specify)	

3.9. Are there any other important issues regarding temperature that affect your work?

4. Lighting

4.1. Please rate your satisfaction with lighting levels in the following areas:

	Very satisfied	Satisfied	Neutral	Unsatisfied	Very unsatisfied
At personal workstation					
General office area					
Common areas (i.e. lunch room/ bathrooms)					
Meeting rooms					

4.2. Have you received any training, education or guidance on energy efficiency in the following areas?

	Tick
Efficient operation of lighting	
After hours operation of lighting	

4.3. Are you able to locate and use the following controls over lighting in your workspace? Please check all that apply.

	Tick
Manual light switches	
Task lighting	
Internal blinds or window shades	
External blinds or shades	
Light switches in meeting rooms	
Other (please specify	

4.4. How do you report any problems with the lighting?

	Tick
Contact the building manager	
Lodge complaint online	
Tell my manager	
I don't usually tell anyone	
Other (please specify)	

4.5. How satisfied are you with response to lighting related complaints?

	Very satisfied	Satisfied	Neutral	Unsatisfied	Very unsatisfied
Level of satisfaction					

4.6. Do any of the following regularly impact your ability to work productively? Please check all that apply.

Flickering lights at workstation	**Tick**
Flickering lights in other common areas	
Glare or reflection at workstation	
Occupancy sensors not working	
Difficulty operating after hours controls	

4.7. Are there any other important issues regarding lighting that affect your work?

5. General building features and equipment

5.1. Please rate your level of satisfaction with the following in your workplace.

	Very satisfied	**Satisfied**	**Neutral**	**Unsatisfied**	**Very unsatisfied**
Proximity to public transport					
Cycling facilities (showers, lockers etc)					
Accessibility to stairs					
Nearby parks					
Car parking					

5.2. Are there any initiatives in your workplace to encourage the following activities? Please check all that apply.

	Tick
Cycling to work	
Taking public transport to work	
Use of stairs instead of lift	
Fitness or physical activity	
Water conservation	
Carpooling/ carsharing	

5.3. Have you used the stairs (instead of lift) today?

Yes ☐ No ☐

5.4. What has been your primary mode of transport to work in the past week?

	Tick
Private car/motorbike	
Carpool	
Public transport	
Bike	
Walking	
Other (please specify)	

6. Organisational culture, sustainability and communication

6.1. How supportive of sustainability do you feel the organisation you work for is?

	Tick
Very supportive	
Somewhat supportive	
Not very supportive	

6.2. Is sustainability or energy efficiency at your workplace important to you personally?

	Tick
Very important	
Somewhat important	
Not important	

6.3. Are you aware of any sustainability initiatives in your workplace?

	Tick
Corporate commitment to sustainability	
Environmental or Energy Management Plan	
Sustainability Committee or staff 'green' team	
Energy efficiency behaviour change programs	

6.4. If these exist, do you think they have been effective in changing workplace behaviour?

	Effective	Somewhat effective	Ineffective
Sustainability Committee or staff 'green' team			
Energy efficiency behaviour change programs			

6.5. Are you aware of any ratings or targets for your building? Please check all that apply.

	Tick
Green Star rating	
NABERS Energy rating	
NABERS Indoor Environment Quality rating	
Energy reduction targets	
Not aware of any	
Other (please specify)	

6.6. Does this building have or use:

	Yes	No	Don't know
Renewable energy systems (e.g. solar photovoltaic)			
GreenPower			

6.7. How are you informed about energy use in your building? Please check all that apply.

	Tick
I'm not informed about energy use	
Written reports published for staff	
Electronic visual displays (i.e. screens)	
Other visual (i.e. noticeboards, posters)	
Informed at meetings or by managers	
Other (please specify)	

6.8. Are you aware of any indoor environment quality testing in your building?

Yes ☐ No ☐

6.9. Do you feel involved in the development and direction of sustainability and energy efficiency initiatives in your organisation?

	Tick
Very involved	
Somewhat involved	
Not involved	

6.10. In your opinion are there any barriers that prevent the building from being more energy efficient?

6.11. In your opinion, are there any barriers that prevent the building from having a higher indoor environment quality (e.g. lighting, temperature, air quality)

7. Other General

7.1. Are there any other issues that affect your productivity at work?

	Tick
Management issues	
Job dissatisfaction	
Morale	
Workplace stress	
Other (please specify)	

7.2. Is there anything else you'd like to include that impacts your productivity and experience at work?

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