

Understanding the Performance of Existing Office Buildings

to inform Energy Reduction Initiatives

The purpose of this project was to provide a low cost, low complexity tool that can be used across the sector and around the world, to assist efforts to improve the energy performance of existing commercial buildings and foster a productive workplace.

Efforts to reduce carbon emissions in the building sector have in the past focused on encouraging green design, construction, and building operation. The business case is not very compelling if considering energy cost savings alone, even with a carbon price, so it is necessary to ensure these savings are associated with broader productivity improvements. There has also been little attention paid to existing commercial buildings, with such buildings making up the majority of the commercial building stock. Furthermore, complexities involved in reducing energy use in existing commercial buildings are not well understood, involving a set of complex and interdependent factors.

Responding to the need for existing buildings to significantly improve in this operating environment, this report presents the key findings of an investigation of factors contributing to whole of building performance, particularly: green design elements; internal environmental quality; occupant experience; agreements and culture; and building management. The resultant 'Performance Nexus' tool has been developed through research, stakeholder workshops, and trials with project partners.¹ The project suggests that the Nexus tool is a low cost, low complexity tool which can be used to encourage the greening of existing commercial buildings through a focus on enhanced productivity.

The research

As part of the Sustainable Built Environment National Research Centre's (SBEnc) focus on industry-led research, two stakeholder workshops were held in the early stages of the project, hosted by SBEnc Core members, the Western Australian Department of Finance in Perth, and the Queensland Government Department of Public Works in Brisbane. The workshops involved the research team presenting the key findings of the literature review and working with a total of 35 key stakeholders to identify areas of interest for the project to develop. The workshop format was based on a methodology where participants were asked to articulate a vision of their ideal green buildings and then consider the enablers and disablers to achieving them.² The workshops were followed by a series of working sessions with partners to identify key areas of interest that were seen to be areas that would provide clear benefits to industry and government.

¹ The 'Productivity Nexus' can be downloaded from the SBEnc and CUSP website.

² Based on the work of Emeritus Professor Valerie Brown



Aims

Based on industry engagement the project focused on:

1. Investigating '*leading efforts*' in Australia and internationally to improve the performance of existing commercial buildings and extract valuable lessons.
2. Identifying '*key performance areas*' of existing commercial buildings to be considered in efforts to improve the energy performance of the building in a manner that supports a productive workplace.
3. Developing a '*framework for collecting data*' in a building to inform low cost, low complexity strategic interventions that capture multiple benefits through more holistic approach.

Key findings

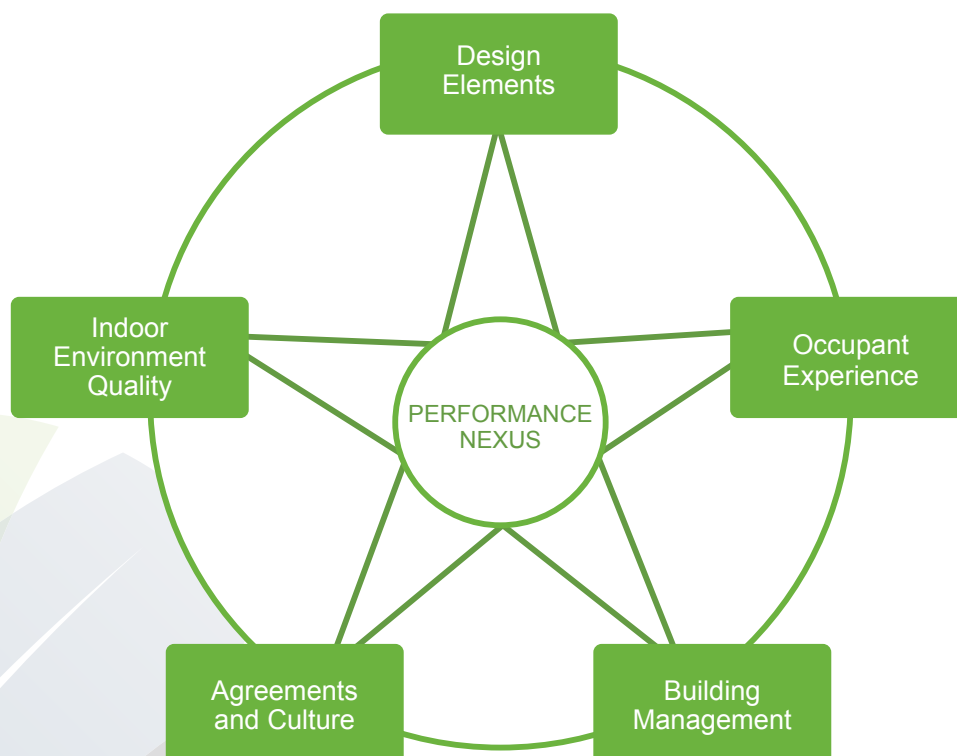
Energy and maintenance costs equate to around 4-5 per cent of total costs over the life-cycle of a building, and occupant salaries equate to around 85 per cent. In the US, productivity losses from poor indoor environmental quality are estimated to be costing as much as US\$22.8 billion per year, and only 14 of the 561 NABERS rated office buildings in 2012 have been rated for indoor environment. Clearly, to reduce energy demand, indoor air quality and other productivity-related factors need to be a focus of any greening activity.

Within the building industry there is a lack of mainstream knowledge and skills in 'green building'. In addition, the industry typically operates in silos meaning that many sub-contractors have set responsibilities with limited collaboration. Furthermore, for multi-tenanted buildings tenants traditionally have relatively little interest in energy related costs, and little knowledge of the ancillary benefits from improving the efficiency of a building. In order to achieve an improvement in both energy performance and productivity, a more holistic 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 simply energy management.

A tool for whole of building performance evaluation

The 'Performance Nexus' for commercial buildings (Figure 1) provides such a framework. The design elements section of the Performance Nexus can act as an anchor point with each element being examined across the other nodes. Structuring the Nexus in this way enables building stakeholders to assess what design elements are in place, how these are being managed and maintained in the building, and how effective this is through Indoor Environment Quality (IEQ) and occupant experience components.

Figure 1: The 'Performance Nexus'



The '*Performance Nexus*' can be used to identify links between the key performance areas to uncover potential strategies for improvement. As an example, Table 1 suggests key questions across the Nexus for the case of lighting.

Table 1: Example of application of each node of the Nexus to ‘lighting’

| Design Element | Indoor Environment Quality | Occupant Experience | Building Management | Agreements and Culture |
|--|---|---|---|---|
| Is the lighting system energy efficient? | Are the lighting levels suitable for tasks? | How satisfied are occupants with light levels and controls? | Is there a maintenance schedule for lighting? | Is there a fit out guide in place for lighting systems? |

Table 2: Typical responsibilities for ‘Performance Nexus’ nodes in commercial buildings

| AUDIENCE | Design Elements | Building Management | Indoor Environment Quality | Occupant Experience | Agreements and Culture |
|----------------------|-----------------|---------------------|----------------------------|---------------------|------------------------|
| Base Building | Building Owner | Building Manager | Building Manager | N/A | Building owner |
| Tenancy | Representative | Manager | Representative | Occupants | Representative |

The ‘Performance Nexus’ tool focuses on five key areas of performance:

- **Design elements:** This node focuses on identifying *key existing energy efficient design elements* within a building and identifying retrofit technologies that could be considered. These includes: monitoring and control technology; lighting; heating, ventilation and air-conditioning; plant and equipment; building fabric; and the tenancy design and fit out.
- **Building Management:** This node considers *the way design elements are used and maintained*, and how information from the other nodes is used in decision-making processes. This includes: operation and management practices; reporting and evaluation; maintenance and cleaning; commissioning and tuning; management personnel; communication and education; and procurement.
- **Occupant satisfaction:** This node considers *how to identify potential problem areas and systems* that are contributing to dissatisfaction in order to rectify the situation. This includes: perceived productivity; communication and reporting; training, education and guidance; and use of controls.
- **Agreements and Culture:** This node considers opportunities for ‘hard’ and ‘soft’ agreements affecting building performance. They include: lease agreements; ratings, mandates and incentives; commitments and targets; organisational culture; and communication and education initiatives.
- **Indoor environment quality:** This node considers how key IEQ parameters can provide valuable guidance for improving conditions as part of efforts to improve energy performance. It includes: basic IEQ monitoring; advanced IEQ monitoring; IEQ management programs; Health and well being; and reporting and communication of results.

Results of trialling the ‘Performance Nexus’ tool

The tool was developed across the five areas by considering global literature, stakeholder workshops, and several trials in Perth and Brisbane with SBEnrc Core Partners. The tool has been designed to target both the base building and tenancies through the use of checklists, questionnaires, and interview questions, designed for particular areas of responsibility, as shown in Table 2.

After adjustments were made to the tool it was then trialled in its final form in several City of Fremantle buildings by

the research team. The result is a tool that guides users through a more holistic approach to the building evaluation process and ensures that key metrics and considerations are included in the process. The ‘Performance Nexus’ is particularly valuable as a pre- and post-retrofit evaluation tool that can effectively highlight the impacts of retrofits to a workplace and identify areas that may need improvement, and where relationships between areas could be strengthened to support improved building performance. The tool is complemented by a series of case studies that investigate how such metrics and considerations are used in practice to improve performance across multiple dimensions. The results show that the tool provides a low-cost, low complexity approach that provides a structure to achieve buy-in from a range of stakeholders involved in the building.

Benefits to government

The key findings provide valuable insight about the range of benefits associated with a more holistic approach to building performance improvement:³

- **Informing legislation and policy development:** The key findings highlight legislation and policy opportunities for government to support a more holistic approach to improving the energy performance of existing commercial buildings. This includes building codes; planning requirements; incentives for existing buildings to undertake retrofit initiatives; workplace agreements (for employees); procurement arrangements (as owners and tenants); and clarity around current and future carbon tax implications for the building industry.
- **Identifying key reporting metrics and areas:** The database review has highlighted a lack of readily accessible data for benchmarking building performance in order to learn from other building examples. This project has highlighted a set of key metrics and considerations that could become part of mandatory reporting requirements.
- **Providing government with succinct capacity building materials:** The deliverables of the project provide materials for capacity building staff with regard to low-cost, low-complexity options for improving energy performance in ways that also improve work conditions and streamline management practices.
- **Informing procurement policies:** The Performance Nexus tool framework provides valuable guidance for procuring services and requiring performance enhancement in existing building retrofits.

³ See Industry Report for further details

Benefits to industry

This project has focused on identifying a set of key criteria to inform efforts to improve the energy performance of existing commercial buildings while also supporting a productive workplace. Industry benefits of this research include:⁴

- **Providing a succinct tool to collect key performance data:** The 'Performance Nexus' provides a valuable tool to identify key performance data and inform efforts to improve the energy performance in a manner that supports a productive workplace.
- **Providing precedent of a more holistic approach to performance improvement:** The 10 Australian case studies investigated provide industry with examples of efforts that take a more holistic approach and consider a range of performance factors.
- **Providing industry with succinct capacity building materials:** The outputs provide a clear and structured set of materials to be used for capacity building including an indication of industry perceptions about taking a more holistic approach to building evaluation.

- **Supporting an expansion in focus from new builds to existing buildings:** The deliverables will support industry to expand into a focus on existing buildings, representing the majority of Australian building stock.
- **Improving strategic positioning:** The Performance Nexus tool enables detection of opportunities across multiple dimensions of a building's operation. This allows building owners to plan for future retrofits with an improved understanding of financial and non-financial implications. It provides a process that enables building managers to focus on how all relevant building occupants can help improve energy performance.

⁴ See Industry Report for further details

The **Sustainable Built Environment National Research Centre (SBEncr)** is the successor to Australia's CRC for Construction Innovation. The SBEncr is a key research broker between industry, government and research organisations servicing the built environment.

The SBEncr is continuing to build an enduring value-adding national research and development centre in sustainable infrastructure and building with significant support from public and private partners around Australia and internationally.

Benefits from SBEncr activities are realised through national, industry and firm-level competitive advantages; market premiums through engagement in the collaborative research and development process; and early adoption of Centre outputs. The Centre integrates research across the economic, social and environmental sustainability areas in programs respectively titled: Driving Productivity through Innovation; People, Processes and Performance; and Greening the Built Environment.

This research wouldn't be possible without the ongoing support of our industry, government and research partners:



Project partners:

- WA Department of Finance
- QLD Department of Housing and Public Works
- Parsons Brinckerhoff
- John Holland
- Curtin University
- Queensland University of Technology
- Townsville City Council
- QED Environmental Services
- HFM Assets
- Green Building Council Australia



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