

Determining the Effectiveness of Green Building Certifications in Terms of Impacts on Sustainability: a Case Study from Australia

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Abstract

Green building is a process of designing a structure in a way that its lifecycle, use, construction, and demolition are all included in the project, so that all areas of sustainability are balanced and maintained. This research on Green Building Certifications focuses on assessing the impact of green buildings over non-green buildings and thus to understand its effectiveness on overall sustainability. The research uses data from two selected States in Australia, namely Victoria and New South Wales (NSW). Both primary and secondary data were used to understand the impact of green building certifications through comparative, descriptive and inferential analysis. These results demonstrated a 54% increase in meeting environmental standards; 57% and 66% in saving of water per m² of the floor area of the buildings in NSW and Victoria, respectively; as well as up to 85% decrease in energy use between green buildings compared to non-green buildings over a 12-year span.

Keywords: Green building; Sustainability; Construction; Certifications; Questionnaire.

1. Introduction

Green Building is a process of designing a structure in a way that its lifecycle, use, construction, and demolition are all included in the project, creating a more sustainable world (Afara et al., 2024; Amen et al., 2024), as all areas of sustainability are balanced and maintained without penalizing one side or another (USEPA, 2016; WGBC, 2023). In New South Wales (NSW), the biggest State of Australia by population, the main Green Building Certifications that are required are now covered by the State Environmental Planning Policy (SEPP)-2023 for Sustainable Buildings. This legislation specifically requires at a bare minimum that the Building Sustainability Index (BASIX) to be used (NSW Government, 2023). Another green certification that is now covered by this legislation is the Nationwide House Energy Rating Scheme. While in Victoria, the second most populous State of Australia, the program of Residential Efficiency Scoreboard Assessments is to be met under the Victoria Energy Upgrades program. This program helps to meet the Victorian Energy Efficiency Certificates, where each certificate that is awarded represents one ton of greenhouse gas that is removed from the construction of buildings. These can work as a rebate and are used to help the building industry to meet their required energy reduction targets.

The core focus of this paper is to assess and quantify the effectiveness of green building certifications in NSW & Victoria, whilst comparing them to non-green buildings in terms of sustainability. This has been achieved through addressing the following objectives:

- To explore the effectiveness of green building certifications in NSW and Victoria, whilst comparing them to non-green buildings, if they meet their sustainability goals.
- To Focus on what the improvements of green building certifications are in sustainability terms whilst contrasting their limitations in their uses.
- To Account for the reasons for gaps in green building certification acceptance and ways to reduce barriers to entry for businesses and individuals.
- To Demonstrate an understanding of how green building certifications work to make recommendations and provide suggested improvements for old buildings trying to achieve a green building certification.

Overall, this paper aims to be able to fill a gap into why green building certifications are effective in two selected States inside Australia. This paper can focus on this idea as it works on being able to breakdown what makes a green building certification effective, how it can better the areas around it but also how it is able to better incorporate green building principles such as the central idea of sustainable buildings and sustainable developments. It is through the research and understandings which are gathered in this paper that the field of green buildings and their various certifications are able to better improved as they are able to learn from what makes each certification different and how each certification is unique whilst also being able to form focus on why it is important to have proper certifications that are focused and beneficial to social, environmental and economic perspectives.

2. Material and Methods

To effectively assess and address the core focus and the objectives of this research, a series of methodologies and tests were used to be able to create results from respondents in building industries in NSW and Victoria. The main form for the collection of data from individuals and companies was using a questionnaire. This questionnaire was sent out to over 45 building industry leaders to gather data and to explore the topic of this paper. The aim of collecting raw data using the questionnaire was to allow for certain parameters and questions to be asked of different people inside the key industry in focus with the hopes of getting a tailored set of responses. This set of parameters allowed for the reduction in drift of

responses with the hope of keeping responses short, concise, and clear allowing for the easy analysis of trends, patterns, and irregularities with the hopes of these being useful towards answering and addressing the scope of this paper. The questionnaire that has been used to obtain complete primary data was created using Qualtrics. In this process, the only information of the responder is their local IP address, of which it is only taken from the nearest city. This means that unless the responders name, their business or organization or personal name are voluntarily disclosed, there is no way for the researcher or the public to be able to tell who the response came from, which ensures the data to be unbiased and confidential.

This questionnaire based response tool included 20 different questions. These questions were broken down into sub-sections to allow for the respondent to be able to answer the questions with a logical progression so that different topics and ideas were put forward to the respondent. The main ideas of the questionnaire included gathering responses for the ideas of sustainability and what it meant in terms of green building certifications. This questionnaire focused on the key principles of sustainability including its impacts on the environment, society, and economics. These questions are critical to the report as the effectiveness of green building certifications relates to the way a building works with the environment, in society and if it is economically viable. Some other forms of response to questions that were put forward to the public was regarding their views as an organization or as an individual with respect to their perceived views on the efficiencies and deficiencies of green building certifications. Questions were also asked to give a quantitative response to a series of questions such as green building certifications impact on saving materials in building and maintenance, water, power and heating and cooling savings. In addition, questions were asked of the respondents regarding their opinions on the green building certifications, ease of information, ability to obtain a certification, obtaining feedback and having a clear and precise determined level system. Once the industry leaders were able to respond, quantitative and qualitative assessments were undertaken on the responses, which include Mann-Whitney U Test; Spearman Rank Order Correlation; Kruskal Wallis Testing; Inferential Analysis; Descriptive Analysis; and Content Analysis.

Secondary sources of information were also a massive part in the forming of understandings and responses to the questions that are posed in this paper. This secondary data through content analysis provided additional depth to this paper as well as adding external real-world data, results, and numbers to support or add value to the topic. Content Analysis plays a large part in the results throughout this paper, this is primarily due to the amount of research and numerical data of value that is available online and in government websites and third-party organisations such as Green Building Council of Australia (GBCA, 2023a). Researchers have investigated aspects of green building certifications such as the benefits they bring provide, but many do not focus on the economical side, especially in Australia when compared against non-green buildings. Researchers have struggled to find primary data from any source such as the Australian Government at either the State or Federal Level leaving a hole for primary data. This means that Content Analysis was appropriate to fill this knowledge gap and to provide accurate, precise, and useful primary and secondary results.

From both primary and secondary sources of information, the results section further developed key ideas and trends that develop between both whilst also highlighting how other research papers and Green Building Certification businesses have found it hard to get a theoretical savings for a green building certification against the real world where not every building or project is perfect and the savings are not always carried forward or seen as being the most important part to the meaning and usefulness of the certification.

Ethically this paper has very little or no concern as all the secondary information that was captured and used in this paper come from published sources such as Government bodies, Non-Government Private bodies as well as businesses and charitable organizations. Some of the central limitations of this research includes the nature of getting true responses, the survey which was the core method of gathering responses relied on the nature of the individual, this being that the researcher hoped that those who were sent the questionnaire in good faith would either respond and have a good response which as much detail as possibly or not respond at all. There were limitations regarding the sample size as the ability for the researcher to gain many responses was hard as the industry is a secretive industry, but this was mitigated as the responses that were sent out to people was sent to a large audience of Tier One, Two and Three Builders and those in the industry.

3. Results and Discussions

Survey results show that green building industry experts are finding that economically and societally there are positives for green buildings and that these do help to address the sustainability of buildings. Table 1 shows how the different experts view savings in sustainability. It relates to the overall impact of Green Building Certifications on developing sustainability. The questions mentioned have the highest to lowest average score, comparing standard deviation, it shows savings in water then energy are the two areas with the lowest standard deviation and the highest are building materials and maintenance costs and in heating and cooling costs.

Table 1. Green Building Certification Impacts in terms of Operational and Construction Savings

Question	Minimum	Maximum	Mean	Standard Deviation
Savings in building materials and maintenance	1	6	3.6	1.62
Savings in water	3	7	5	1.41
Savings in energy	5	7	6	0.89
Savings in heating and colling	2	7	4	1.79

Green building experts have been able to ensure savings in both water and energy usage with not as much savings in gas. This is important that as these buildings use less and less power and water, the environment can be spared the burden of having to deal with the increased demand and usage of natural resources. Environmentally it has been observed that these green buildings do not meet the needs of reducing material demand for the construction nor reducing the need for materials in the upkeep. As per the experts’ responses above there is no saving in materials, showing a downside to these certifications.

The findings in Table 1 are crucial in being able to produce a need for more critical focus into effectively making greater changes in the built environment, whilst limiting the number of materials, energy, water and heating and cooling needed. This shows that not all Green Building Certifications are created equally and that there are always some certifications that are more effective in producing change. This shows that as time goes on there will always be a need for more growth in this space and that today’s standards will not always be the future needs in these certifications. This is to say that the current standards are good but there is still more room for growth and to promote the effective transformation of the Green Building sector.

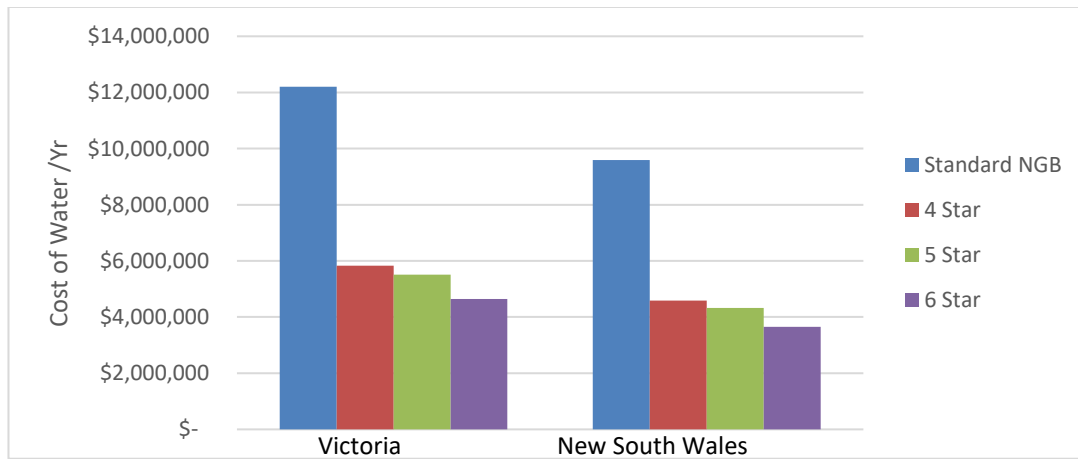


Figure 1. Cost of Water Per Year in Victoria & New South Wales (Adapted from: GBCAb, 2013)

Results in Figure 1 have been obtained through analyzing some secondary data. As per these results, the level of Green Building Certification increases that the level of water usage and therefore the cost of using this water decreases. It has been found that the highest cost of water being used is when there is an NGB (Non-green building) and the cheapest cost of water in both the States comes in the six-star certified buildings. This outcome from this graph is a crucial finding as it supports the findings of Table 1. As buildings obtain Green Star Certification, the level of consumption of water decreases hence the cost of using water is heavily reduced. It has been seen that a Standard NGB will use \$12,000,000 per year worth of water in Victoria whilst in NSW the average NGB will use \$10,000,000. It shows that in Victoria consumption drops more than half, to \$6,000,000 per year and in NSW the drop is to \$5,000,000. This represents a 55% drop in water in both States when comparing NGB to Green Certified Buildings.

This drop in the overall cost of using water in Green Buildings is fundamental as it shows that there is a clear need and use for these certifications whilst showing how drastically the drop in consumption of water in these buildings can be. This can be attributed to the implementation of less water demanding appliances and the use of better systems to help prevent loss of water decreasing demand.

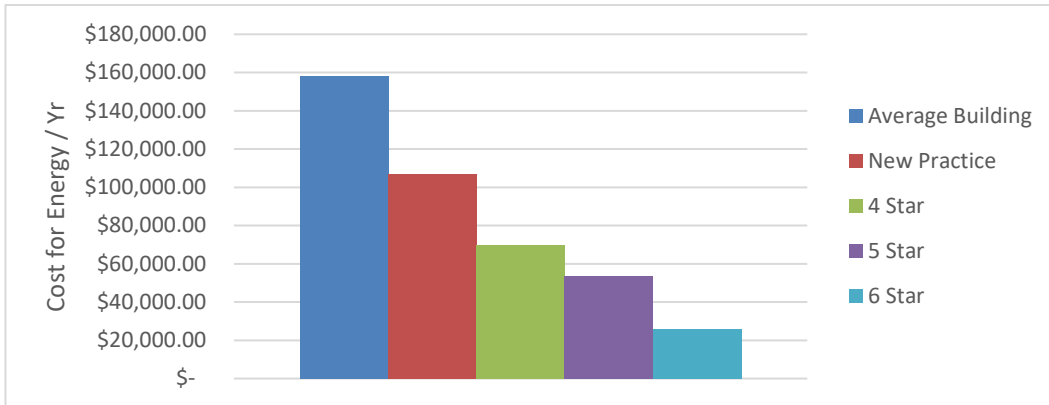


Figure 2. Operational Energy Usage of Traditional Buildings Compared to Green Star Certifications (Adapted from: Warren, 2009; GBCAb, 2013; AEMC, 2018; ACCC, 2023)

Further, Figure 2 summarizes results from some secondary data sources, which shows that as the level of Green Star certification increases, savings increase. Portrayed above is the cost of an NGB which sits at \$160,000 per year spent on electricity and when the new practice category, Green Star ratings 1-3 the drop is to \$110,000. This represents a drop of 32%. A level 4-star green star certification goes all the way down to \$70,000, a 37% drop. The next drop is down to \$50,000 and then roughly \$30,000. This shows an 80% drop in electricity costs per year. This is not to say that there are not large savings that can be found in this area, it is important to remember to obtain a Green Star level 6 building, the building must meet a stringent marking criterion, which costs the builders time and money to reach such level.

Further research conducted in this study, helps to argue and suggest that Victorians compared to NSW experts find the benefits of Green Building certifications in being able to positively impact the Green Building space to be 60% in Victoria and 55% in New South Wales. Most of this difference between both States can be attributed to the smaller number of Victorians who response. But this data set is important as it shows how the different natures of the climate is beneficial to Green Buildings. Green Buildings allow for more sunlight, and heat from the ambient atmosphere, which ultimately helps to save on heating.

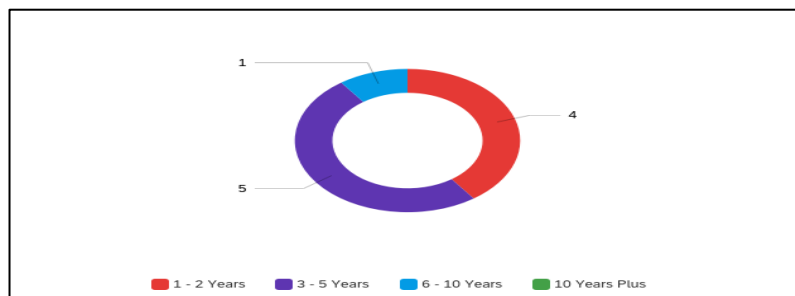


Figure 3. Experts Years of Use of Green Building Certifications

Figure 3 shows the results on the experts' years of use of green building certifications, compiled from the questionnaire. The experts were asked to respond to how many years of use they had with any Green Building certification whether that was a government run certification process or a private industry certification process. In the figure above, it provides deep insight into the current state of Green Building Certification processes and to what extent these certifications perform a vital role in the construction industry. It has been revealed that there were four responses from the experts in the 1 to 2-year category date range, five people responded to the 3 to 5-year range and lastly only one person responded to the 6 to 10-year range. There were no responses to this last possible avenue of answer parameter being the 10 years plus category. For this question, there was a response rate of 77%, meaning that of the 13 or so responses, there were 10 people who responded to this question in the questionnaire. From these responses it shows that roughly half of the people are new to this. These results highlight a major shift in green space. The NSW Government has started to legislate changes in sustainability mandating it in all major works. Some of these key changes include introducing BASIX certification process. This is a government run initiative used as a precursor to any development which costs more the \$50,000. This certification is aimed at giving an award to stating these development meets the minimum standard. The aim of this certification is to get people more familiar with new measures.

The respondents were also asked how many Green Certified Buildings and NGBs their company maintains. The results are presented in Figure 4, which shows that respondents in NSW have more green buildings to maintain and operate compared to Victoria. The Victorian Government has put into practice new legislation and compliance towards small homes and their builders which aims to provide a record of efficiency as well as a newer market of small home green builders that are able to meet new compliance and to complete work effectively to a set criterion for building and material efficiency. This

Victorian initiative works to calculate a home’s base efficiency and productivity using lower-level machines and appliances and creates both a cost path and a thinking path to a higher level of efficiency in terms of heating, cooling and electricity used and produced.

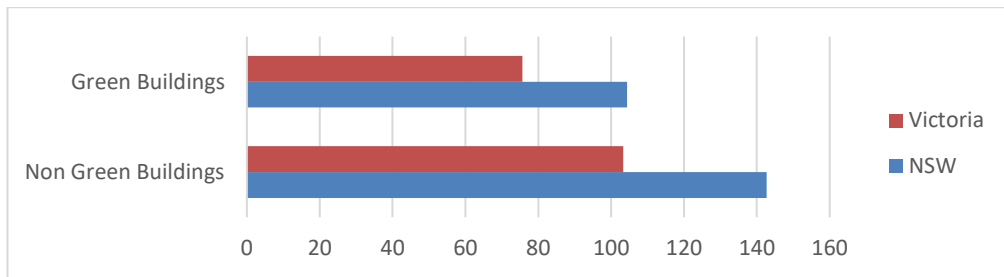


Figure 4. Comparison of Number of Green Buildings and NGBs maintained by the respondents

Results in Figure 5 show the state of electricity and gas usage in NSW. The market for electricity is shown to be roughly 4,200,000 Mega Watt Hours (MWh), whilst the total amount of gas used and produced in the market is 3,000,000 Giga Joules (GJ), in 2016. Three years later it shows a substantial change in the market’s composition in terms of a decrease in energy demand, especially electricity. The baseline result indicates a 58-42 percent split in electricity to gas in the market, whereas three years later the market has moved to 41-59 percent split in electricity to gas demand. Such results demonstrate the need for more focus into ways to help minimize the impacts of heating and cooling on green buildings but also ways that allow for the easier modernization of non-green buildings into becoming green buildings, through methods that incorporate the key pillars and foundations of sustainability.

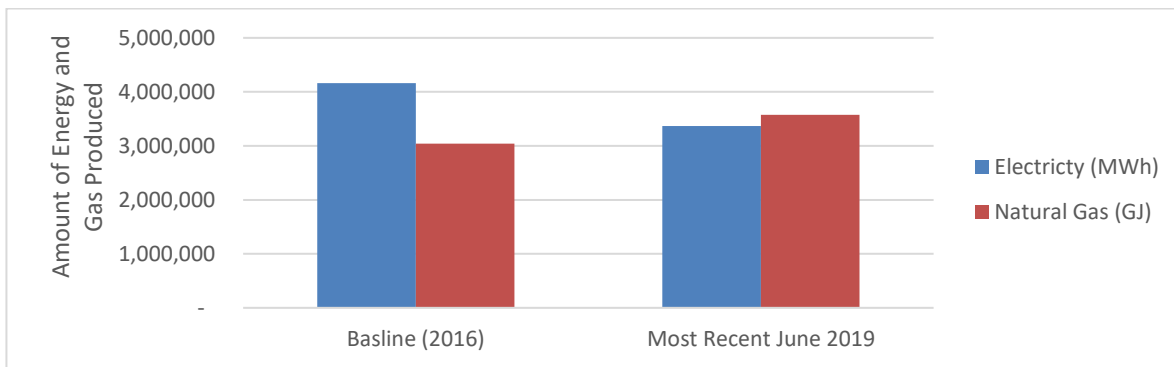


Figure 5. Electricity and gas usage in NSW between 2016-2019
Adapted from: GESPR, 2017a and 2020b

On the other hand, results in Figure 6 show the state of electricity and gas usage in Victoria between 2018 to 2022. The total electricity needing to have dropped substantially from 46,000,000 MWh to 33,000,000 MWh over the span of four to five years in Victoria. An interesting point of note that arises in these results is how the total demand for gas has stayed relatively consistent, a drop of only 1,000,000 MJ over the span of four years, a roughly 2% drop each year, opposed to the 6% drop in electricity over the same time span.

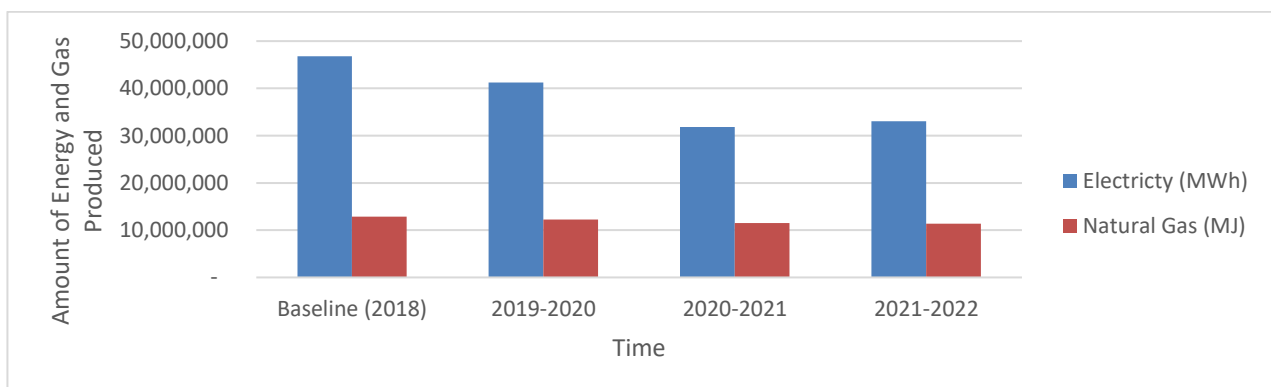


Figure 6. Electricity and gas usage in Victoria between 2018-2022
Adapted from: VDELWP, 2022 and ESC, 2024

Generally, in both States, there has been a market wide reduction in the electricity usage. As time has passed and there has been more and more market capitalization in terms of using a Green Building Certification, which shows a major swing and pivot towards gas. In Victoria, there has been a general drop in demand for electricity but there has not been a major increase in gas. The reason why this change is important as it shows that both States are moving in their own separate routes to improving sustainability, but it also shows that there is no single cohesive certification for green buildings that is being pushed one more than the other in each of these States.

Experts from NSW have opined that the need for better and more creative building material design was of worthwhile use in design for green buildings. This is contrasted to Victorian experts that felt slightly stronger with 77% of experts from the State feeling a need and a want for better choices in material design for green buildings. These responses from both NSW experts and Victorian experts are in line with each other and present a concurrent idea that the green building space is ever growing but that it is not perfect. Some experts from these States mentioned that the sector already tried to encompass these issues but there are more worthwhile and pressing issues that would better advance the movement of green buildings and their attached certifications. These results have been illustrated in Table 2.

Table 2. Industry expert responses to the needs of Green Buildings from business perspective

Business Perspective	Need for better a more creative building and material design	Need for more efficient air flow and air modelling internally	Need for less points awarded for waste and their correct recycling	Need for more efficient life cycle based buildings
NSW Positive Responses	9	11	6	10
Total Responses (NSW)	13	13	13	13
Victoria Positive Responses	10	9	7	10
Total Responses (Victoria)	12	12	12	13

Responses were sought from the experts if they felt that there was a need for better points in certification systems for how a building is ventilated and how air interacts both internally and externally with the building. In this business perspective, experts from NSW responded with higher positives than that of Victorian experts. This being 85% of NSW experts and only 70% of Victorian experts found this to be a worthwhile area of change and further development in certifications, as illustrated in Table 2.

Overall, green buildings and certifications in both NSW and Victoria are improving and there is a positive development in building sustainability. This is important as it sets precedence for the ever-growing developing nature of green buildings. This develops the trend and themes of the findings of this study and the work that is being done and completed by the Green Building Industry. It is important to demonstrate adequate change and growth in this area, but as the research also shows, particularly in the usage of gas and the swapping to alternative fuel sources for key elements of building it is shown that there is still much more growth and development needed in these areas of green buildings to make these certifications more efficient, effective and useful in the modern 21st century. This is to say that the work of Green Building Certifications and Green Building are fundamental in improving the sustainability of the future but there is still a lot of work that needs to be completed for this industry if it wants to be able to attract new users, more and better green buildings, as well as more cost effective and less risk based building approaches whilst using a Green Building certification.

5. Conclusions

Green Building Certification is like a steppingstone to improving overall sustainability in NSW and Victoria. The research and outcomes in this study demonstrate how there will be positives and negatives to different Green Building Certifications. This was completed above by focusing on the effectiveness of Green Building Certifications in NSW and Victoria. Upon completion of this focus, a comparative analysis of different Green Buildings and their various certifications was undertaken, and results were compared against NGBs, the biggest competitor to green buildings and their certification processes. The key findings of this study include:

- A 50% reduction in water costs between a non-green building and a level Six Green Star Certified Building.
- The energy savings between Green Buildings and NGBs being 87% total reduction in energy consumption.
- Ninety percent of experts in NSW and Victoria are limited in Green Building Experience within the five-year range.
- The divide between Green Buildings and NGBs in both States is that NSW is at 50% equality whilst Victoria is at 40% towards Non-Green Buildings.
- In NSW there is a 20% drop in electricity and a 20% swing towards more gas, while in Victoria there is a 33% decrease in electricity use and 2% drop in gas in green buildings.

The findings from this study show NSW is sitting at a greener position when compared to Victoria due to improved legislation, better market conditions, cheaper prices for certain basic running and material costs but also through how the perception of Green Buildings are run and covered in the State. It is due to this that the NSW Certification systems that are in place are more efficient than Victoria. But consequently, when comparing these States against traditional NGBs these

certification processes in both States as well as the state of sustainable buildings in both States are doing a better process at making the world more sustainable when compared to older buildings. This is important as it shows how there is still always room for more work and focus into the green building sector as this area is constantly growing and developing due to the different inputs from all aspects of the world, the environments input and output is being better managed, the social impacts and benefits are being better respected and the economy is thriving due to the increased competition and demand for better sustainable programs.

Some further research that would be beneficial to the sustainable building sector is ways to reduce total energy demand in all forms within various certifications such as how NSW changed from general electricity with some gas to a proportionally large increase in gas market share of the energy market. Some other focus that has been identified in this research is why NSW and Victoria have similarly based Green Building certifications, that these two States are on opposites regarding the rise of gas in the energy market mixture and what further problems that may develop. Additional study and development regarding technology for heating and cooling, that is both sustainable and green building friendly, have been identified as being a vital aspect of missing work not captured by this report but can now be. The last area that has been identified from this paper that requires additional effort is in the end-of-life cycle of buildings, how to manage a transition from a NGB to a green building and being able to create better practices and standards which set the green building up for the successful transition to more and more green buildings not just in NSW and Victoria but also across Australia.

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Conflict of Interests

The Authors declare that there is no conflict of interest.

References

- ACCC (Australian Competition & Consumer Commission), 2023. 'Inquiry into the National Electricity Market 2018-25 reports', viewed on 18 April 2023. <<https://www.accc.gov.au/about-us/publications/serial-publications/inquiry-into-the-national-electricity-market-2018-25-reports?page=0>>
- AEMC (Australian Energy Market Commission), 2018. 'Residential electricity price trends 2018', viewed on 25 March 2023. <<https://www.aemc.gov.au/market-reviews-advice/residential-electricity-price-trends-2018>>
- Afara, A., Amen, M. A., Ayoubi, M. El, Ramadhan, D., & Alani, J. (2024). Arguing Faux Biophilia Concepts in F&B Interior Design: A Case Study Applied in Duhok City. *Civil Engineering and Architecture*, 12(2), 1091–1103. <https://doi.org/10.13189/cea.2024.120231>
- Amen, M. A., Afara, A., & Muhy-Al-din, S. S. (2024). The Persuasibility of Globe Thermometer in Predicting Indoor Thermal Comfort Using Non-standard Globe Diameter: Row Houses of Semi-Arid Climates as Case Studies. *Civil Engineering and Architecture*, 12(1), 425–435. <https://doi.org/10.13189/cea.2024.120132>
- ESC (Essential Services Commission), 2024. 'Victorian Energy Market Report', viewed on 12 April 2024. <<https://www.esc.vic.gov.au/electricity-and-gas/market-performance-and-reporting/victorian-energy-market-report>>
- GBCAa (Green Building Council of Australia), 2023. 'What is Green Building', viewed on 21 April 2023. <<https://new.gbca.org.au/about/what-green-building/>>
- GBCAb (Green Building Council of Australia), 2013. 'The Value of Green Star – A Decade of Environmental Benefits', viewed on 23 May 2023. <https://www.gbca.org.au/uploads/194/34754/The_Value_of_Green_Star_A_Decade_of_Environmental_Benefits.pdf>
- GESPRa (Green Environmental Sustainability Progress Report), 2017. 'Green Report Jan to Jun 2017', City of Sydney, viewed on 15 May 2023. <https://www.cityofsydney.nsw.gov.au/-/media/corporate/files/2020-07-migrated/files_g/green-report-jan-to-jun-2017-final.pdf?download=true>
- GESPRb (Green Environmental Sustainability Progress Report), 2020. 'Green Progress Report January to June 2020', City of Sydney, viewed on 15 May 2023. <<https://www.cityofsydney.nsw.gov.au/-/media/corporate/files/publications/surveys-case-studies-reports/green-reports/green-report-progress-report-january-to-june-2020.pdf?download=true>>
- NSW (New South Wales) Government 2023, 'BASIX Help Notes Sections', Viewed on 20 April 2023. <<https://www.basix.nsw.gov.au/iframe/81-about-basix.html>>
- USEPA (United States Environmental Protection Agency), 2016. 'Basic Information', viewed on 21 April 2023. <<https://archive.epa.gov/greenbuilding/web/html/about.html>>
- VDELWP (Victoria Department of Environment, Land, Water and Planning), 2022. 'Annual Report 2021-22', viewed on 10 May 2024. <https://www.delwp.vic.gov.au/__data/assets/word_doc/0026/604916/Annual-Report-2021-22-accessible-version.docx>
- Warren, C.M.J., 2009. 'Who needs a Green Star?', Pacific Rim Real Estate Society Conference, Sydney 19-21 January 2009, viewed on 20 March 2023. <https://www.researchgate.net/publication/43498871_Who_needs_a_Green_Star>

WGBC (World Green Building Council), 2023. 'About Green Building', viewed on 15 April 2023.
<<https://worldgbc.org/about-us/#>>