Achieving sustainability and carbon neutrality in higher education institutions

A review

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Abstract: Universities and higher education institutions play an important role in achieving a sustainable future through their teaching and by undertaking cutting edge research to combat climate change. There have been several efforts towards a sustainable future and achieving carbon neutrality at higher education institutions in Australia and around the world. This study has reviewed the sustainability strategies of numerous universities in Australia and has identified as study cases six universities that are committed to and leading the implementation of initiatives to achieve carbon neutrality. The initiatives implemented at the selected universities were classified into eight "sustainability categories", namely, built environment, energy, food and gardens, GHG emissions, natural environment, resource and waste management, transport, and water. Among the selected leading universities in sustainability, Charles Sturt University and the University of Tasmania (UTAS) are the only universities in Australia certified as carbon neutral. An interesting aspect of this review is the way in which universities are implementing sustainability initiatives in line with their mission and strategies. Despite striving towards the same end goal of achieving carbon neutrality, different institutions offer individually unique approaches towards sustainability. For example, UTAS values the creation, expansion and dissemination of knowledge and the promotion of continual learning, which is clearly demonstrated through its initiatives and policies. The findings in this review are critical in identifying those institutions of higher education which are role models in their strong commitment to achieving carbon neutrality. Such role model universities can pave the way for similar climate action at other universities.

Keywords: global warming; net zero emissions; sustainable campus; climate action; GHG emissions

1. Introduction

Global warming is one of the most pressing concerns facing humanity today. Anthropogenic activities have been shown to result in negative impacts on the environment through increasing greenhouse gas (GHG) emissions [1]. Climate change and its effects are a fact of life that people are currently confronted with. There have been talks about intergenerational equity and developing a sustainable way of life as an approach to combatting this worldwide threat [2]. As sustainability can be a difficult concept to grasp, there are many different perspectives on what it means to be sustainable [3]. In 2015, 196 nations signed the Paris Climate Accord with the objective of limiting global warming to far below 2 °C above pre-industrial levels and pursuing extra measures to reduce it to 1.5 °C above pre-industrial levels. To keep global warming below 1.5 °C, immediate action is needed to cut global GHG emissions by 44% below 2010 levels by 2030, with net zero emissions

by 2050 [4–7]. Carbon neutrality is defined in a variety of ways; thus, it is critical to have a common consensus in order to avoid any misunderstanding. The Publicly Available Specification by the British Standards Institution (BSI PAS 2060) defines carbon neutrality as the absence of net GHG emissions during a certain time period, while the Carbon Neutral Cities Alliance (CNCA) describes it as a goal of cutting GHG emissions by 80–100% by 2050 or sooner when compared to the baseline year of 1990 [8]. The two documents, BSI PAS 2060 and CNCA, are similar in their conclusions in the sense that a city's net GHG emissions should be zero at some point in the future during a predetermined period.

It is a widely held view that higher education institutions have the capacity to influence climate change responses not only through their research and education, but also through their commitments to renewables and climate change mitigation and adaptation within their operations [9–12]. Reassessing a university's quest to achieve sustainability through commitments and implementing sustainable development policies are important steps towards reducing its GHG emissions and achieving carbon neutrality [13,14]. According to the three categories of infrastructure, community, and learning, these should unfold and interrelate to transform sustainable practices and make up the foundations of a sustainable campus [15]. Although it takes time to integrate sustainable development policies and practices into an institutional process, especially in the higher education sector, numerous universities around the world are working to achieve this transition, recognising their moral obligations to address the environmental consequences of their own actions and to inspire and educate the next generation to act responsibly. Universities can help to reduce GHG emissions and to make the transition to carbon neutral systems. The educational benefit of achieving carbon neutrality is enormous, as these activities provide hands-on learning opportunities for tomorrow's citizens and climate leaders [16]. A carbon-neutral university is one of numerous local initiatives being implemented by higher educational institutions throughout the world to promote sustainable development via systematic institutional changes at the local level [17]. The fundamental difficulty for universities is to determine how to reduce their own carbon footprint. Fortunately, the universities that have been able to break the barrier and overcome this difficulty can be a major resource to help many other universities achieve this goal towards sustainability.

Australia is dedicated to meeting the United Nations Sustainable Development Goals (UNSDGs); however, compared to commitment and action at the global level, Australia has achieved rankings below the regional average score when assessed in 2018 with 155 other countries. This shows that in terms of development towards the UNSDGs, Australia falls behind other advanced nations. According to the findings of one study, Australia shows a mixed performance in achieving the UNSDGs, with excellent development in health and education targets but a slow growth in climate action goals [18]. While many Australian universities are basing their activities on the UNSDGs, which include drastically reducing carbon footprints, there is no general guideline for Australian universities to follow as each university has implemented initiatives in a variety of different areas. Examples include Charles Sturt University and the University of Tasmania, which have audited and reduced their emissions, and received carbon neutral certification in 2015 and 2016, respectively. These are the only two universities in Australia to have already achieved carbon neutrality. A few institutions have been making divestment from fossil fuels the centrepiece in their climate action plans, with the movement started by La Trobe University in 2016. Along with universities integrating divestment in their actions, efforts are underway to persuade other organisations related to Australia's higher education sector, such as UniSuper, a 450,000-member higher education superannuation fund, to divest from fossil fuel. While this is important, some universities have focused on generating their own renewable electricity. Deakin University has established an industrial scale microgrid, while the University of Queensland has built and operated a million-dollar solar farm to offset their power. Other universities have followed closely, with hopes of transitioning to 100% renewable power [19]. While several universities have made a start toward achieving sustainability

and carbon neutrality, they must be more ambitious to put Australia back on track towards meeting the UNSDGs.

There is very limited literature available on the subject of achieving 100% carbon neutrality among higher education universities, and the purpose of this study is to contribute to the scant literature. This paper is mainly focused on selected leading universities in Australia, and provides an analysis and comparison of their plans and initiatives towards sustainability and achieving carbon neutrality. This analysis will provide valuable inputs on how universities in Australia compare to one another and how their progress towards carbon neutrality can be achieved. To obtain a global perspective on sustainability in higher education institutions, some leading universities from around the globe will be examined as well. The goal is that the knowledge and ideas presented as outcomes of this study may be useful to other higher education institutions in their attempts to improve sustainable development and move towards achieving carbon neutrality and beyond. This research will assess the carbon neutral status of universities in Australia and across the globe in order to determine how they incorporate sustainable practices and how they work with the UNSDGs to achieve carbon neutrality within the set timeframe. This will influence how numerous institutions around the world utilise different or similar means to reach the same target. Furthermore, this will aid in providing comparisons between universities in Australia as they plan various frameworks and strategies to achieve carbon neutrality. This study also demonstrates what needs to be done to reach carbon neutrality. As a result, it compares and analyses the various available sustainability strategies which universities can implement. Although case studies on carbon neutral universities from other parts of the world are available, they do not compare initiatives on a national level [17]. Unlike previous studies, this research will serve as a general guideline for higher education institutions through an analysis and comparison of sustainability initiatives at universities in Australia, which will help such institutions contribute to climate action and the UNSDGs.

Thus, the specific scope of this study can be summarised as follows:

- Determine the major contributing factors of GHG emissions in universities
- Look at ways to reduce these major contributing elements
- Identify the key strategies that have been implemented in universities mainly in Australia to be fully carbon neutral
- Compare and analyse selected leading universities in Australia and outside Australia in terms of their strategies to achieve sustainability and carbon neutrality
- Create common guidelines or directions about strategies and initiatives which other universities can follow.

This review paper is structured as follows. The second section presents the methods used in selecting the case study universities. This is followed in Section 3 by a detailed review of sustainability strategies implemented at selected universities in Australia and outside Australia. The fourth section then presents a detailed discussion based on the outcomes of this study; finally, conclusions drawn from the study are presented in Section 5.

2. Methods

In recent years, human activities have contributed to significant climate change around the globe. As a result, countries worldwide are focusing on reducing greenhouse gas emissions and mitigating climate change [20]. The undertaking of critical research on combating this problem through carbon reduction and promotion of sustainable strategies stems from higher education institutions, which play a significant role through their research, teaching and implementation of strategies and policies to address these concerns.

The review undertaken in this study was conducted in two stages. The initial Stage 1 of this review aimed to undertake a thorough online review of the literature to identify the higher education universities in Australia that are implementing sustainability initiatives with the aim of achieving carbon neutrality. The online literature comprised research journal papers from scientific databases (ScienceDirect, Scopus and Google Scholar), books, and university reports and publications. University publications were obtained from their

respective websites. It was imperative that the data collected be as recent as possible, with relevant information that addresses climate action at higher education institutions. Since university strategies were only available through their publications and were constrained in terms of how recent they were. In Stage 1 of this literature review, fifteen universities in Australia which were implementing various sustainability initiatives were identified.

The way in which these fifteen universities in Australia identified in Stage 1 implemented various sustainability initiatives was observed and how they are achieving carbon neutrality was assessed to varying degrees. The initiatives implemented at the selected universities were classified into eight "sustainability categories", namely built environment, energy, food and gardens, GHG emissions, natural environment, resource and waste management, transport, and water.

In the Stage 2 of this review, the initially identified list of 15 universities was further narrowed down to select 'case study universities' which were potentially making significant progress towards achieving carbon neutrality. The case study universities were identified based on their performance in the above-listed eight sustainability criteria and their strong commitment to achieving carbon neutrality. Another criterion for selecting the case study universities was based on the Climate Active Neutral Standard and whether the universities are taking steps to achieve that certification. Based on these criteria, six "case study universities" in Australia were identified in Stage 2: the University of Tasmania (UTAS), Charles Sturt University, the University of Melbourne, the University of New South Wales (UNSW), Monash University, and RMIT University. As mentioned earlier, thus far only Charles Sturt University and UTAS have been certified as carbon neutral in Australia. While most universities have a net zero aim of 2050 or sooner, the six universities chosen as case study universities have demonstrated greater commitment and progress in their sustainability programmes and ambitions to achieve carbon neutrality. The criteria considered for selecting the case study universities are summarised in Figure 1.

Figure 1. Selection criteria used for identifying the case study universities. Data Source: [21,22].

In the next section, the sustainability strategies being implemented by the six case study universities are analysed and compared across the eight identified sustainability categories.

3. Sustainability Strategies

Since the focus of this paper is to review the sustainability initiatives undertaken at universities in Australia and the steps they are taking towards achieving carbon neutrality,

this section will first discuss in detail and compare how Australian universities have taken up various sustainability initiatives. A brief discussion on the goals and strategies of some leading universities outside Australia is also presented in this section.

3.1. Sustainability at Australian Universities

In Australia, universities need to consider the Climate Active Carbon Neutral Standard for Organisations set by the Australian government to obtain their climate neutral certifications. This is a voluntary standard for reducing GHG emissions and attaining carbon neutrality. It gives best-practice recommendations on how to monitor, reduce, offset, validate, and report emissions generated by an organisation's operations. Climate Active is Australia's collaborative climate action project, and it is the only government-backed programme that allows all levels of Australian society to collaborate to reduce carbon emissions. The Organization Standard is based on international norms that have been adjusted to the Australian context. Emissions are divided into three scopes (Scope 1, Scope 2 and Scope 3) to better distinguish between different emission sources as illustrated in Figure 2, the data for which is taken from the Climate Active Carbon Neutral Standard for Organisations [21]. It can be noted that university-owned fleet vehicles for fossil fuel powered internal combustion engines are Scope 1 emissions but are classified as Scope 2 emissions if electric vehicles are powered by off-site generated electricity.
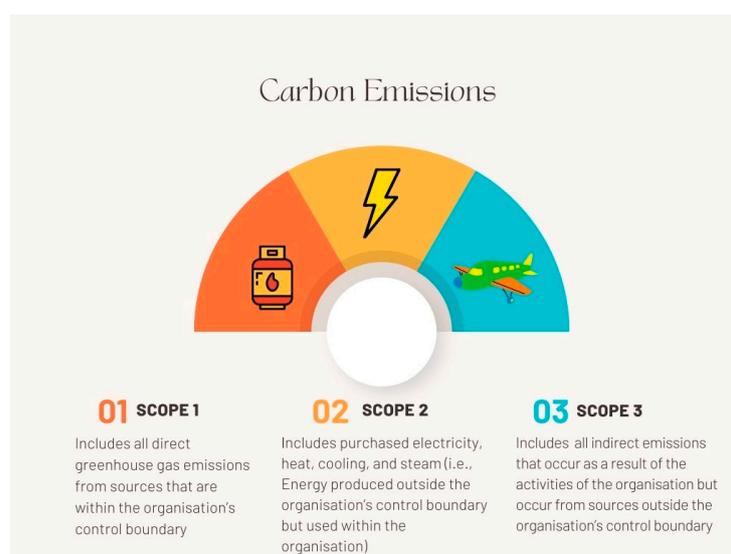

Figure 2. Classification of carbon emission scopes. Data source: [21].

To achieve carbon neutral certification by the Climate Active Carbon Neutral Standard, universities must:

- Measure and reduce emissions where possible
- Offset remaining emissions
- Publicly report on their carbon neutrality
- Undertake independent validation (i.e., audit or verification) by an environmental auditor or carbon consultant at least once every three years.

The following sub-sections break down the sustainability initiatives according to the eight identified sustainability categories. It is aimed at identifying similarities as well as differences in strategies that the case study universities are implementing to pave a pathway towards achieving carbon neutrality.

3.1.1. Built Environment

The term "sustainable building" refers to both the structure of a building and the application of environmentally responsible and resource-efficient techniques throughout

its life cycle: planning, design, construction, operation, maintenance, renovation, and deconstruction [22].

The Sustainability Integration Program for Students (SIPS) at UTAS links sustainability outcomes with student experience, allowing them to experience real world sustainability challenges; it has been an important part of all university initiatives, including in its impact on the university's performance in the sustainability categories. The university established Governance Principle GLP9 on Environmental Sustainability in 2005, stating that "environmental preservation and sustainability are fundamental concerns in how the University functions". The first Sustainable Environment Designs Policy was authorised in 2008, followed by the creation of the "Design Requirements—University of Tasmania" document, which was first made public in 2009 [23]. Following a review of the university's policy approach, which used lean concepts, the built environment principles of the university were incorporated into the sustainability policy in 2020. At all phases of the design and construction processes, any actions that have an impact on the natural and built environment are identified and resolved. Environmentally sustainable design (ESD) elements are discovered throughout the preparation of university clearance alternatives along with all building operations, including demolition and deconstruction. Several big projects have gained 5-star Green Star certification or above in recent years. In 2012, their Medical Science Precinct 2 became Tasmania's first educational building to get a Green Star designation for environmental design [22].

A set of guidelines have been prepared to allow and promote the incorporation of ecologically friendly projects into the built environment at Charles Sturt University. These rules are part of the operational project design requirements of the university. Through sustainable building design and construction, they have integrated sustainability into the built environment of the university. Charles Sturt University has a sizable and diverse property portfolio spread throughout its campuses. Typically, the university owns a building from design and construction to operation, restoration, and re-purposing, and demolition. Charles Sturt is conscious of the impact of these assets' running expenses and benefits from the building stock's whole-of-life efficiencies. The footprint for the running costs is established during the design and construction phase. Charles Sturt's Port Macquarie Stage 2A building project applied the ARUP Sustainable Project Appraisal Routine (SPeAR) during design and construction. This allowed the building to incorporate sustainable features such as a 164 kW rooftop solar energy system to maximise self-generation, a high-performance building façade designed to maximise benefits through shading, glazing and other materials, traffic light control for the air conditioning system designed to provide building users with feedback on when to use natural ventilation, smart metering linked to the university energy management system to monitor utility consumption, and local and sustainable materials [24].

The Green Building Council of Australia (GBCA) has awarded the University of Melbourne's Parkville campus a 6-star Green Star—Communities designation, recognising international leadership in sustainable master planning. It is the first time an Australian university has received a 6-star—Communities grade [25]. The Green Facility Council of Australia awarded the university's new Melbourne School of Design building a 6-star Green Star Design—Education Design v1 Rating. Only 12 buildings in Australia have been awarded a 6-star Green Star Education Design—v1 certification, and this is the largest. Notably, this structure is the only one to have ever received all ten innovation points available in the evaluation criteria. The Old Quadrangle, the oldest building on the Parkville campus, is being redeveloped as the university's major cultural, civic, engagement, and ceremonial heart. To maximise sustainability outcomes while honouring the heritage and uniqueness of this historic precinct, adaptive reuse and novel heating and cooling techniques are being used. The university's priority actions include embedding ESD principles throughout project lifecycles, investigating leading global standards applicable to precinct-level design and development, reviewing, and updating the University's Design Standards to enable the integration of sustainability commitments, developing guidelines

for ESD standards for both major and minor refurbishments, and implementing a zero-emissions-ready approach to all campus deconstruction [26].

The development of the UNSW campuses provides a chance to establish healthy and regenerative environments for study and employment that use natural resources as little as possible in their construction and operation. A framework has been developed to establish their approach to sustainable design in new building and refurbishment projects, resulting in fit-for-purpose and future-proofed facilities. The Roundhouse public domain project was finished in 2020, resulting in the activation of the first portion of College Walk, a new pedestrian-focused route connecting to the recently inaugurated light rail terminus on Anzac Parade. In the same year, a new UNSW Health Translation Hub (HTH) and a new multi-level Biomedical Science Centre schematic design was created in accordance with UNSW minimum sustainable design criteria, which are comparable to the 5-star Green Star Design and As Built and 5.5-star NABERS Energy ratings. The university has also set a target for 2022 where new buildings must be designed and built to achieve a minimum of 5-star Green Star Design and As Built or equivalent and 5.5-star NABERS Energy equivalent [27]. The institution is dedicated to incorporating leading environmental sustainability ideas and practises into the design and operation of buildings and campuses.

The new Chancellery and Woodside Building for Technology and Design, which opened in 2020, demonstrates Monash University's dedication to designing and constructing buildings that provide occupant comfort and healthy interior environments. Both of these structures were designed and constructed using the Passive House 'fabric first' design process. Both the Woodside Building for Technology and the new Chancellery have received formal Passive House accreditation, and both are well-insulated, sealed, and shaded, with dedicated fresh-air systems. Both buildings contain an all-electric power plant and rooftop solar panels. These buildings will be connected to the campus microgrid (electricity) and collected water network, in addition to having low energy and water use, to enable more efficient use of resources both within the buildings and throughout campus. Water-sensitive landscapes have been created around each of these structures. By 2030, the university intends to include ecologically sustainable development in all new building and renovations, as well as to electrify all existing structures [28].

RMIT University's Sustainable Design Principles give explicit advice for capital project designers and consultants to guarantee that industry best practise sustainable results are delivered throughout the lifecycle of RMIT's new and existing venues. The university strives for sustainable outcomes in capital projects by encouraging design and operation practises that promote passive design to reduce building energy consumption, materials selection that prioritises low toxicity, low environmental impact materials, supply chain transparency, circular economy principles, active and sustainable transportation, and good health and wellbeing for all occupants. RMIT has a long history of support for the Green Star rating methodology as a founding member of GBCA and regards the Green Star framework as a clear and consistent methodology for recognising sustainability successes. All new developments and large refurbishments must attain a minimum 5-star Green Star As Built accreditation. The university currently has seven 5-star Green Star rated buildings, with Building 106 recently 5-star rated in 2021. This facility was created with health and wellness in mind, with fresh air and plenty of natural light throughout. The lighting control was created with the goal of maximising natural light in the space. Particulate and toxin levels in paints, sealants, carpets, furniture, and cleaning chemicals have been kept to a minimum, and the furniture chosen must have high third-party sustainability and ergonomic ratings. Indoor plants have been evenly placed throughout the building to improve the quality of the indoor environment and to ensure that people feel connected to nature even when they are indoors [29]. Table 1 presents a summary of built environment-related sustainability initiatives at the six selected Australian universities.

Table 1. Summary of initiatives at the six selected universities under 'built environment' category.

University of Tasmania	Sustainable environment design policy approved in 2008 Built environment policies now included in the sustainability policy Environmentally sustainable design is made aware and included in all projects Major projects have received/registered for 5-star Green Star certification SIPS built environment related projects conducted
Charles Sturt University	High-performance building facade, modelled to achieve maximum benefits through shading, glazing and other materials selected Local and sustainably sourced materials used in buildings
University of Melbourne	Redevelopment project of the Old Quad building with sustainable features First university to achieve a 6-star Green Star Communities rating for Parkville campus in 2017 More than six 5-star Green Star Design rated buildings
University of New South Wales	New buildings designed to be zero emission in operation Roundhouse public domain works completed, new pedestrian focused route linking to the newly opened light rail stop Schematic design completed for new Health Translation Hub and Biomedical Science Centre buildings in line with UNSW sustainable design requirements Planning to design and build new buildings to minimum 5-star Green Star Design by 2022
Monash University	All new buildings are electric, with roof top solar All new buildings designed to Passive House principles Existing campus buildings are to be electrified by 2030
RMIT University	RMIT Sustainable Design Standards used for all projects Currently has seven 5-star Green Star rated buildings

3.1.2. Energy

Sustainable energy entails the consumption of less energy from non-renewable energy sources (such as fossil fuels) and use of more renewable energy sources (such as solar, wind, rain and geothermal heat). Energy management at UTAS aims to reduce carbon emissions and energy consumption costs by implementing strategies, systems, procurement, and development. Energy performance contracts, including building management and control system upgrades, are among the recent energy reduction initiatives taken by the university. Buildings and systems are monitored to verify that they are operating efficiently. Other initiatives include photovoltaic and solar hot water system installation, upgrading lighting systems to LED (light emitting diode), LPG (liquified petroleum gas) and diesel fuel replacement with natural gas, and ensuring that all large new construction projects receive a 5-star Green Star rating. Energy challenges and competitions for university faculty and students are also being organised and conducted. The university's Energy Strategic Plan commits to monitoring, evaluating, and reporting on key indicators, for which UTAS collects a variety of data.

Charles Sturt University had the largest rooftop PV system in 2017, and this deployment has continued to the point where solar is now installed on the great majority of structurally sound rooftops. The university's 2030 Clean Energy Strategy lays forth a plan to become more energy resilient, efficient, and prepared for a low-carbon future. They plan to eliminate all scope 1 and 2 emissions from their activities by 2030; however, this will be a considerable task given that natural gas derived from fossil fuels accounts for half of the university's stationary energy demands. The strategy will focus on primary areas such as external power purchase agreements that will contract energy only from

solar and wind sources, energy efficiency, further onsite renewable and energy storage, electric vehicles, elimination of natural gas, and energy productivity The Enterprise Space Register Integration project aims to share instructional space utilisation data recorded in the university timetabling system in order to improve space management. The university can improve security and reduce energy consumption in scheduled instructional rooms by sharing this information. This is accomplished by transitioning from generic weekly schedules for when spaces should be unlocked and air-conditioned to actual, timetabled bookings driving the operation of these systems.

The University of Melbourne is reinforcing its commitment to reduce fossil fuel use and take advantage of possibilities to source emissions-free energy both on and off campus. The university consumes a large amount of energy for its power needs, primarily from electricity and gas. The global warming impacts of fossil fuel use have a meaningful impact on this need. Through on-campus energy projects, the goal is to reach zero net emissions from electricity by 2021 and to reduce emissions by 20,000 tonnes of carbon per year by 2020. The university received funding from the Clean Energy Finance Corporation (CEFC) in 2015 to carry out a number of renewable energy generation and energy efficiency initiatives on campuses. Rooftop solar generating, voltage optimisation, and efficient freezer renovations are among the measures that are intended to lower the university's carbon footprint by almost 9000 tonnes per year.

Since November 2020, UNSW has begun receiving emissions-free renewable electricity, allowing the university to realise their aim of generating net zero energy-related emissions by 2020. The 15-year solar supply arrangement with UNSW and Maoneng is the first of its kind in Australia, bringing together a retailer, developer, and corporation. UNSW considers itself the first university in the world to achieve full energy carbon neutrality, with solar photovoltaics meeting 100% of its demands [30]. The central energy plant's building controls at Ainsworth Building (J17) were upgraded to improve system performance and energy efficiency. Furthermore, to properly condition occupied spaces, a demand-based control for the Hilmer Building (E10) air conditioning system was implemented which included the installation of extra passive infrared motion sensors (PIR) and integration with the building management system (BMS). To reduce heating and cooling demand, air conditioning setpoints were adjusted based on ambient temperature for most big buildings with BMS.

In 2018, Monash University agreed to a Power Purchase Agreement with Murra Warra Wind Farm. The construction of Monash's turbines was commenced in September 2019, and the practical completion occurred on 1 January 2020. This arrangement supplied enough capacity to meet the university's existing electricity use. In 2017, a substantial rooftop solar programme began, increasing total capacity across all campuses by 300%. Combined with the Murra Warra Wind Farm Power Purchase Agreement, Monash University is on track to meet its 2020 and 2030 renewable energy targets of achieving 55% renewable electricity and 4MW of on-site solar capacity by 2020. In 2019–20 three new solar PV systems were erected, giving Monash a total rooftop solar capacity of 4.1MW. An additional 11,500 LED lights were installed in 2020 to replace inefficient T8/T12 fluorescent lighting. Heating, ventilation, and air conditioning (HVAC) plant optimisation, equipment schedule optimisation and pump and variable speed control were accomplished as essential energy conservation measures at the Clayton and Caulfield campuses as part of stage one of the Building Optimisation Program. By modernising and utilising campus assets, the university's Net Zero Initiative intends to support the transition to an energy-efficient, renewable energy-powered future. Its foundational principles include significant energy saving measures in existing buildings, performance criteria for new construction, and collaboration with industry partners and communities to help create a more sustainable future [31].

In Australia, RMIT has gained the lead in renewable energy contracts, starting with the original Melbourne Renewable Energy Project (MREP) in collaboration with the City of Melbourne and 12 additional partners in 2017. It was the first time in Australia that

a consortium of local governments, cultural organisations, colleges, and corporations bought renewable energy from a freshly constructed facility. The 14 members of the purchasing club pooled their purchasing power to enable the development of a 39-turbine, 80-MW windfarm near Ararat. The university then led a second, much larger buying group known as Melbourne Renewable Energy Project 2 (MREP2) to contract long-term renewable energy in 2020. Since January 2021, 22 RMIT buildings across the City and Bundoora East campuses have been powered by 100% carbon neutral electricity [29]. RMIT is not only improving its energy supply profile through this role, it is also taking other organisations along for the experience and leading by example. RMIT has invested in solar PV on the roofs of the university's buildings, maximising the usage of on-site renewable energy generation whenever practical. The university's existing solar 603kW PV portfolio produced 595,000kWh of renewable electricity in 2020. Table 2 presents a summary of energy-related initiatives at the six selected Australian universities.

Table 2. Summary of initiatives at the six selected universities under the category of 'energy'.

University of Tasmania	Energy strategic plan monitors, evaluates and reports key indicators Building performance data collected with GHG emissions from university's energy use Energy reduction initiatives including PV installation, LED lightings, and monitoring buildings/systems SIPS energy related projects conducted
Charles Sturt University	Solar installations across all campuses Publishing a Clean Energy Strategy 2030 Planning to contract electricity only from solar & wind sources Further onsite renewables and energy storage added Eliminating natural gas with clean electric systems
University of Melbourne	Target to achieve zero net emissions from electricity by 2021 Obtained finance in 2015 for renewable energy generation and energy efficiency projects including solar installations, voltage optimisation and efficient freezer upgrades
University of New South Wales	Switched to 100% renewable electricity from 2020 Energy efficiency initiatives implemented including building controls and set point optimisation
Monash University	Power purchase agreement with Murra Warra wind farm in 2018 Target for 55% renewable energy and 4MW solar capacity by 2020 Installation of solar PV systems Installation of LED lighting and HVAC plant optimisation Implementation of Net Zero Strategy
RMIT University	100% carbon neutral electricity on all 22 RMIT buildings since January 2021 Signed a second renewable contract in 2020 under MREP2 Installation of solar PV on rooftops

3.1.3. Food and Gardens

Agriculture, forestry, and fisheries, when done properly, can supply nutritious food for all while also generating acceptable incomes, supporting people-centred development, and conserving the environment.

UTAS's Procurement Policy oversees all university procurement-related activities and specifies the university's commercial strategy to managing the acquisition of products and services from vendors, contractors, and suppliers. UTAS has a long history of environmental education and research, as well as of raising public awareness of the necessity of competent environmental management. Consistent with this, the university focuses on best practise management of the environmental effect of university operations. This is reflected in UTAS's Strategic Plan 2019–2024, which shows the university's commitment to enhancing Tasmania's environmental sustainability. Fresh food can be obtained on

campus from a variety of edible gardens, orchards, food allotments, and individual trees. Some are open to all employees and students, while others have limited access. UTAS has begun using STARS (Sustainability Tracking, Assessment, and Rating System) to track its sustainability performance as of 2019. Food and beverage purchases and sustainable dining are two relevant food categories within STARS. The concluding category includes attempts to reduce food and eating waste as well as assistance for sustainable food systems.

Professor Geoff Garr at Charles Sturt University is the leader of an Australian and worldwide research team and has spent the last 22 years exploring ways to achieve food security while lowering reliance on non-renewable, ecologically damaging inputs via biocontrol methods. The university's sustainability advisors conducted a program in 2020 in which each of the advisors chose a focus area for the year including growing the collection of food and organic waste in the Albury–Wodonga campus. They were also able to expand the collecting of food organic waste into dwellings utilised for defence staff housing when manning border closures.

Bees@UniMelb is a new programme at the University of Melbourne aimed at educating employees and students on campus about bees and beekeeping. The university maintains many beehive locations on campus and started Bees@UniMelb Honey in 2016. In addition to producing delicious honey, these bees help to increase inner-city fruit and vegetable production by pollinating neighbouring plants. A student-led Fair Food Challenge at the university in 2017 engaged in a co-design process established a set of fair food principles to effect positive change in Australian university campus food systems. For the challenge, the Fair Food UniCycle was built, a movable cargo bike meant to make fair and sustainable on-campus food and cooking easier. The bike enabled students and the broader community to participate in food education, skill development, and outreach programmes [32].

While the introduction of a Plastic Free Dining programme at UNSW was delayed due to a decline in campus activities, it included the development of a supporting marketing campaign and was launched at the start of Term 1 2021. This included requiring all single-use campus food packaging to be 100% compostable by 2021, as well as encouraging UNSW students and employees to dine in and bring their own (BYO) cups and containers. As part of the university's Green Impact programme, a crew created an Indigenous edible garden on College Walk near Alumni Park. The garden is filled with Banksia Scrub from the Eastern Suburbs, native Geraniums, and creeping violets, all of which can be collected for traditional bush tucker. The garden is designed to serve as a hub for educational and awareness programmes.

Monash University collaborated with Monash Green Steps students in December of 2020 to conduct a rigorous materials audit of the pre-packaged beverages offered on campus. The goal is to better identify what types of pre-packaged beverage materials are offered on campus and how the new Victorian Container Deposit Scheme to be implemented in 2022/2023 will affect Monash University. The goal of this research was to identify problems with packaging and to make recommendations. The university launched a BorrowCup programme, which was put on hold in 2020 due to the COVID-19 pandemic. This reusable BorrowCup at campus cafes allowed students and staff to return it to any of the specific collection bins situated throughout campus or at participating cafes. Many on-campus cafes also provide a coffee discount to promote participation in the programme.

The university's operational footprint and food supply chain have a substantial impact on RMIT. This enables the university to use its purchasing power to improve supply chain processes and support the strategic goal of altering the world. RMIT welcomed three Indigenous companies to its catering panel and one to its marketing panel in 2019. Several catering panel members collaborate with food organisations such as SecondBite to ensure that good quality leftover food is donated to those in need rather than going to waste. The Sustainable Retail Framework was also developed to assist and encourage RMIT retailers to become more environmentally friendly in their day-to-day operations. Participating RMIT merchants can implement up to 20 environmental or social sustainability projects and be awarded a bronze, silver, or gold rating based on the number of sustainability

initiatives completed. Among these initiatives are discounts for customers who bring their own containers and coffee cups, developing menus that use seasonal fruit and vegetables, increasing the proportion of vegetable dishes and purchasing only high welfare meat while serving vegetarian and vegan meals daily, purchasing products from local or fair-trade suppliers, and eliminating single-use plastic drink bottles and coffee cups.

A summary of sustainability initiatives related to 'food and gardens' at the six selected universities in Australia is presented in Table 3.

Table 3. Summary of initiatives at the six selected universities under the category of 'food and gardens'.

University of Tasmania	Edible gardens, orchards, food allotments and individual trees available to source fresh food on campus Embedding sustainability principles into catering contracts Working with progressing procurement of local food in Tasmania SIPS food & gardens related projects conducted
Charles Sturt University	Professor Geoff's research leads an Australian and international team that has spent the last 22 years investigating how to achieve food security whilst reducing dependence on non-renewable, environmentally hazardous inputs through the biocontrol solutions Food organic waste collection program implemented
University of Melbourne	The University has several beehive sites on campus and, in 2016, launched Bees@UniMelb Honey Fair Food Challenge involved establishing fair food principles
University of New South Wales	Encouraging dine in and BYO food containers at campuses Indigenous edible garden developed
Monash University	Providing discounts on BYO coffee cups and reusable BorrowCup Pre-packaged beverage audit conducted by students
RMIT University	Collaborating to ensure leftover food from caterers is donated Sustainable Retail Framework created to encourage retailers to becoming sustainable

3.1.4. Greenhouse Gas (GHG) Emissions

GHG are gases that absorb and radiate heat from infrared radiation. Almost all of the rise in GHG in the atmosphere during the last 150 years can be attributed to human activities. This is the primary activity contributing to global climate change.

UTAS is committed to assisting in the construction of a zero-carbon society, as evidenced by its carbon neutral certification since 2016 by the Climate Active Carbon Neutral Standard and its commitment to complete divestment by the end of 2021. The university has committed to using a negative investment screen for fossil fuels and a positive investment screen for companies and funds that support the UNSDGs, with the goal of totally divesting from fossil fuel-exposed investment funds. In April 2021, the University joined Race to Zero, which is a global effort that seeks to mobilise leadership and support from businesses, cities, regions, educational institutions and investors for a healthy, resilient, zero-carbon recovery that prevents future risks, provides good employment, and unlocks inclusive, sustainable growth. The Race to Zero criteria includes achieving net zero emissions by 2050 or sooner, describing the steps that will be followed to achieve net zero, taking action towards net zero while documenting where carbon reductions are being made and making a commitment to report progress on an annual basis. By participating in Race to Zero, UTAS has agreed to meeting these criteria as a carbon neutral organisation. UTAS reports its GHG emissions through their GHG Inventory.

Charles Sturt University, Australia's first certified carbon neutral university, maintained its emissions reduction objective by offsetting its remaining total emissions through the acquisition of certified carbon credits. In accordance with Climate Active's carbon

neutrality standards, the university acquires and retires offsets in arrears of the reporting period. This is done once the annual carbon emissions inventory has been established, resulting in the total number of offsets needed. Charles Sturt University has devised a set of four criteria to help guide judgments regarding carbon offset acquisition. These are the guiding principles:

- Financial assistance for locally based projects to the degree that they are deemed financially viable
- A preference for initiatives that are in line with the principles of Charles Sturt University and provide a high level of engagement
- Projects that provide regional linkage with the university's foreign partners are being considered
- The offset option's unit cost.

The projects that are being carried out include a biodiversity reserve project in Indonesia, a wind power project in India, and an indigenous savanna fire project in the Northern Territory in Australia.

The University of Melbourne releases information on GHG emissions, energy production and energy consumption under the National Greenhouse and Energy Reporting Act 2007. The University is committed to bringing forward its carbon neutrality target, which they expect to reach before 2030. The University of Melbourne is also the first in Australia to conduct a nitrogen footprint assessment of its activities and to implement the Green Impact sustainability engagement programme. The nitrogen footprint tool created by researchers at the university measures reactive nitrogen, which is the nitrogen released into the environment as a result of daily activities such as food consumption, transport, and energy usage. The researchers discovered that the University of Melbourne has a nitrogen footprint of 139 tonnes of nitrogen, with three components dominating: food (37%), energy use (32%), and transportation (28%). It might be lowered by 60% if action is taken to minimise emissions from those three major contributors. The investigation discovered that 96% of nitrogen emissions occurred outside the university's limits.

UNSW's attention now shifts to indirect (scope 3) emissions across their value chain, having reached net zero energy-related (scope 1 and 2) emissions by 2020. Scope 3 includes emissions from acquired goods and services, construction, investments, and travel, which can be higher but are more difficult and require longer-term organisational reform and supply chain engagement. Typically, value chain emission sources are not mentioned in university targets and emissions policies. During 2020, the UNSW Council accepted UNSW's new carbon reduction target, which was produced using the Science Based Targets Initiative's (SBTi) process. Total emissions must be reduced in accordance with a 1.5 °C science-based target, which corresponds to a 30% reduction by 2025, a 50% decrease by 2030, and net zero emissions by 2050. UNSW's Net Zero Strategy was developed in the same year and sets out how they plan to achieve their 2030 target of a 50% reduction, focusing on their largest remaining emissions sources, supply chain and investment activities. The Net Zero Strategy comprises nine initiatives through which the university will reduce emissions by engaging suppliers, changing behaviours, and adapting processes. After revising its divestment resolution in 2019, UNSW also built a Responsible Investment Framework to properly align UNSW's investing activities to the Environmental Sustainability Plan, its aims, and UNSW's other responsible investment commitments.

Monash University pledged in 2017 to achieve net zero emissions for its Australian campuses by 2030. Since 2005, Monash University's carbon footprint has been calculated for each year. Since 2009, the carbon footprint has included GHG emissions linked with Australian activities over which the university has operational control, as the university continues to conduct carbon audits. When compared to the 2018 carbon footprint, the university's gross total emissions dropped by 3.2% in 2019. In comparison to 2019, GHG emissions from gas used for heating and cooling (included in Scope 1 emissions) increased by 1.1%, while emissions from electricity use (included in Scope 2 emissions) declined by 6.2%.

RMIT is making tangible efforts and launching creative programmes to achieve carbon neutrality by 2030 and adapt to climate change. Guided by the Carbon Management Plan, the university engages in a variety of emissions-reduction measures to achieve this goal. This plan provides strategic advice for RMIT to manage its operational GHG emissions profile and explores future scenarios. It also acts as the university's commitment to accurately measure, report, and manage the university's emissions profile. The Plan is updated every two years and aims to represent best practises in pollution management. RMIT achieved a 62% reduction in operational emissions from the baseline emissions in 2007. The institution accounts for all energy and emissions produced and consumed within the building profile under the Australian operating emissions profile. RMIT calculates all building emissions (Scope 1 and 2 emissions, intensity, and reductions) using the required Australian Government factors, which are consistent with the National Greenhouse and Energy Reporting (NGER) Act.

A summary of sustainability initiatives under the category of 'GHG emissions' at the six selected universities is presented in Table 4.

Table 4. Summary of initiatives at the six selected universities under the category of 'GHG emissions'.

University of Tasmania	Certified as carbon neutral since 2016 Committing to full divestment by the end of 2021 Joining Race to Zero for zero carbon recovery in 2021 GHG emissions data collected and published in an inventory SIPS GHG related projects conducted
Charles Sturt University	Australia's first carbon neutral certified university since 2016 Focussing on reducing emissions through offsets
University of Melbourne	Target to achieve zero net emissions by 2030 GHG inventory reports published to provide an assessment of GHG emissions First university in Australia to undertake a nitrogen footprint of its operations
University of New South Wales	Target to achieve zero net emissions by 2050 Completed their Net Zero Strategy Developed a responsible investment framework updated investment policy to reflect divestment
Monash University	Target to achieve net zero emissions by 2030 3.2% gross GHG reduction in 2019
RMIT University	Aims to become carbon neutral by 2030 Carbon Management Plan published to manage GHG emissions

3.1.5. Natural Environment

The natural environment includes all living and non-living objects that have evolved naturally over millions of years inside the biosphere: landscapes, oceans, water, atmosphere, and biodiversity. A healthy natural environment allows human life to flourish and is crucial to our well-being. Human actions, on the other hand, have impacted the natural environment on a vast scale in the modern world.

By adopting the Governance Principle GLP9 on Environmental Management in 2005, UTAS recognised that environmental preservation and sustainability are essential priority in the way the university functions and subsequently developed the University's Environmental Management Plan 2009–2011. This strategy sought net positive environmental outcomes, with one of the primary goals being to manage and promote biodiversity in an ecologically suitable manner in collaboration with the many campus communities. So far, this goal has been met by including the protection and enhancement of the natural environment as a key component for the University Reserve's Fire Management Plan (Sandy Bay campus), which includes weed suppression and encouraging endemic flora and fauna communities, significant multi-year efforts delivering protection and improvement

of Newnham Creek (Newnham campus), feral animal and weed control, and penguin nesting protection. A University Natural Space Management Strategic Plan is currently being prepared, and when completed, it will be made public. This strategic plan will lead the entire university community in attaining their natural environment objectives, which include the conservation of native species and their habitats, as well as the reduction of human environmental impacts.

Charles Sturt University's Summer Hill Creek rehabilitation is still ongoing due to a collaboration between the university, Orange City Council, the Department of Primary Industries, and Landcare. Following the removal of willows from this portion of the stream last year, about 810 native trees and shrubs suited to the local environment were planted over 2020 in the area known as Risky Paddock alongside Summer Hill Creek as it flows through the Charles Sturt farm. Tree planting events were also held in the Wagga Wagga campus, with 1200 seedlings planted across three sites. In summary, a total of 2205 native trees were planted across all campuses in 2020, with approximately 22,000 trees planted since 2010. The Successful Sustainability at Charles Sturt University Grant has established squirrel glider habitat and nesting sites on the Albury–Wodonga campus. In late 2020, a volunteer team lead by Dr. Jonathon Howard constructed roughly 40 nest boxes and planted hundreds of indigenous and appropriate trees in an effort to support the campus's remaining squirrel glider population, as these have been listed as a vulnerable species in New South Wales.

The System Garden at the University of Melbourne, founded in 1856, is one of the country's oldest teaching gardens. Plants in the garden are divided into subclasses and families, allowing visitors to learn by comparing the form and floral structure of various plant species. It is a member of the Climate Change Alliance of Botanic Gardens and is actively working with organisations worldwide to protect cherished botanical landscapes from climate change [33]. To attract pollinator species to Parkville's System Garden, an insect motel has been erected in an unused entryway of the Botany Building. A minor renovation of the System Garden is planned for 2021, which will include the introduction of indigenous plants. The university's Melbourne Business Practicum (MBP) is a rigorous subject in which a small team of Masters students is assigned to an industry partner to address a current, pressing need. MBP students collaborated with the Royal Botanic Gardens Victoria on one of the earliest projects, beginning a carbon audit of the gardens' whole operations.

Along with complementing the built environment, the Roundhouse public domain works at UNSW saw a net increase of 17 native trees, with additional plants carefully selected to promote species diversity and be fit for a heavily pedestrianised region. Trees at the UNSW campuses are managed using a tree database system and an interactive campus tree plan [34].

Monash University intends to draw on the distinctively Australian experience to create multi-functional spaces that provide enjoyment for humans, the wider community, and wildlife, including flocks of bird species that seek refuge and food among gardens each year on their migration treks. The clever, sustainable design of the university's gardens will see the continuous implementation of permeable pathways, rainwater harvesting and treatment networks, and permeable pathways to capture, reuse, and re-purpose this valuable resource throughout campus landscapes. From 2015 to 2020, there was no net decline in canopy cover on any Monash University campus, as the institution aims for 30% canopy cover by 2030 [35]. The university's key projects also include establishing vital habitats and productive gardens on campus, as well as growing an urban forest to create comfortable landscapes and microclimates.

RMIT demonstrates its appreciation for trees and the environment by including a tree heritage path on the Bundoora campus, where more than 90 river red gums are placed along the Keelbundoora Scar Tree and Heritage Trail. Six of them are scar trees, from which the bark was cut to build carry-alls, infant beds, and canoes, a harvesting process used by hundreds of generations of Australia's Indigenous people. Although the trees are centuries

old, the trail, named for a Wurundjeri clan progenitor, was established in 2008 to conserve the vegetation's significant cultural and biological significance. Shadeways, a new digital platform developed by RMIT researchers, is assisting local governments in determining where to prioritise tree planting to increase shadier walkways for pedestrians and bikers during the hotter months. Ngarara Place, located in the heart of RMIT's City campus, is an Indigenous garden. The unique location, created, constructed, and built primarily by Indigenous people, contains an Indigenous-themed courtyard area, amphitheatre-style seating, a sculptural laser-cut smoking pit, and a space to host Indigenous ceremonies, meetings, and events [36,37].

A summary of sustainability initiatives under the category of 'natural environment' at the six selected Australian universities is presented in Table 5.

Table 5. Summary of initiatives at the six selected universities under the category of 'natural environment'.

University	Initiatives
University of Tasmania	Inclusion of the protection and enhancement of natural environment through suppression of weeds and encouraging flora & fauna communities Feral animal control and protection of penguin nesting habitat at West Park campus Protection and improvement of Newnham Creek at Newnham campus Conducting assessments related to threated species, weeds, and natural values & threats SIPS natural environment related projects conducted
Charles Sturt University	Annual planting events with targeted habitat zones and species More than 20,000 native trees planted in the last 10 years Re-establishing nest boxes designed to create a resilient squirrel glider population
University of Melbourne	The System Garden in Parkville is a member of the Climate Change Alliance of the Botanic Gardens working with organisations around the world to protect botanic landscapes
University of New South Wales	New native trees and shrubs planted to provide species diversity
Monash University	No net decrease in canopy cover at each campus from 2015 to 2020, targeting 30% canopy cover by 2030 Establishing valuable habitats and growing an urban forest targeted
RMIT University	Tree heritage trail on campus Digital tree planting platform developed Indigenous garden on campus

3.1.6. Resource and Waste Management

Sustainable resource and waste management entails the use of material resources efficiently in order to limit waste production while dealing with waste in a way that actively contributes to the economic, social, and environmental goals of sustainable development. University students and staff consume a considerable number of products and services as a result of their studies, teaching, research, and overall living and working at the university. Each purchase has an impact because of the cumulative impact of the product's creation, transportation, use, and disposal.

The Sustainability Committee approved the UTAS Waste Minimisation Action Plan 2021–2025 in April 2021. This plan directs the entire university community in accomplishing their resource recovery and waste minimisation goals by implementing a waste hierarchy in all university operations and activities. UTAS generates a considerable amount of discarded furniture that can be reused each year. The Re-Use Program is a university-wide online catalogue and furniture redistribution system. The university promotes improved resource recovery on campus through its expanding Resource Recovery Program (RRP), with the

goal of quantifying waste generation, improving opportunities for resource recovery from all waste types, and determining the infrastructure, services, and logistics solutions required to support a comprehensive resource recovery programme. UTAS, with the assistance of Hobart City Council, established a trial recycling wall for difficult-to-recycle objects on the Sandy Bay campus in December 2019. Because of the pilot wall's initial success, the service is being expanded to other southern universities and buildings. The university is committed to monitoring and reporting key metrics related to resource purchase and recovery, for which it gathers a variety of data.

The Green Labs Program at Charles Sturt University, which is separated into four units, energy, water, purchasing, and recycling, describes activities that can be implemented at both individual and organisational levels. Sustainable laboratories are crucial for the institution considering they take up 5.6% of the total floor area. Since laboratories provide potential for conservation, the Green Labs Program seeks to reduce waste generation without jeopardising integrity or safety. On the Wagga Wagga campus, a dedicated food organics collection system was implemented in 2020. This system collects organic waste from the principal commercial kitchen and composts it at a nearby commercial processing facility. Improved procedures were implemented to handle old office furniture through a donation program created with local schools and non-profit organisations. This equipment is now put to good use and is being kept out of landfills. To assist divert computers from landfills, the Finance and Welfare Team distributed 18 reconditioned staff laptops to students in need through the laptop equity initiative in 2020. Building contractors have always been required to document and report on their waste and recycling activities at Charles Sturt and are now proactively urged to reuse and recycle remodelling waste.

The challenging environment at the University of Melbourne, with a continually shifting population, has resulted in an adaptive waste management strategy that trials, tests, and monitors in diverse ways. Priority initiatives include considering waste minimisation in purchase decisions, increasing recycling rates by improving bin labelling and placement, increasing the scope of the Reuse Program to include the recovery of all equipment and furnishings, looking at larger-scale recycling options for organics, measuring waste data by disposal method on a daily basis and reporting on a regular basis, and enhancing contractor management to guarantee proper garbage disposal. Waste audits are undertaken with the goal of reducing waste to landfill to 20kg per person by 2020, which is a 70% reduction from the original baseline in 2012.

UNSW completed a revised Waste Management Plan in early 2020, outlining the future course for sustainable waste management. It provides a plan of action to increase waste segregation, satisfaction, and sustainability. The introduction of a new three-bin system for outdoor areas means that the university now classifies waste into food waste and compostable packaging, drink containers, and general waste. A new furniture reuse portal was created allowing used furniture to be kept when not in use and made available to any UNSW unit via an easy-to-use online interface. The approach fosters the reduction of trash to landfill while making optimum use of university resources. In early 2021, 126 furniture items were sold to students and employees at low cost during an overflow furniture sale. In addition, all campuses adopted 100% single-use biodegradable packaging as part of the Plastic Free Dining effort. UNSW targets to conserve natural resources, save money, and raise waste awareness among students and employees by improving waste procedures and behaviours.

Using the concept of the circular economy, Monash University has established a strategy to transform the university into a zero-waste facility. The method focuses on maximising the value of all resources by reducing trash from campuses and leaving only lucrative recycling streams. The approach covers a wide variety of waste streams, with organic waste separation and treatment being a top objective. An important goal for the university is to reduce total trash to landfill by 20% per FTE (Full Time Equivalent) + EFTSL (Equivalent Full-Time Student Load) in 2020, compared to 2015 levels (tonnes/EFTSL+FTE), along with being able to recycle 50% of the university's total waste. Monash University has

prioritised reducing the overall volume of paper purchased, which was greatly decreased in 2020 due to the COVID-19 pandemic. In 2019–2020, recycled content paper accounted for 41% of all paper purchases. Monash Print Services' conversion to carbon-neutral virgin paper was the most significant change in paper supply in 2019. Despite the fact that this reduced the percentage of paper with recycled material, 80% of Monash's paper purchases were certified by both the Programme for the Endorsement of Forest Certification (PEFC) and the Australian government's National Carbon Offset Standard (NCOS) Carbon Neutral Program. Monash intends to seek paper with 100% recycled content and carbon-neutral certification by 2021.

RMIT intends to enhance waste management practises across its campuses by following the Waste Management Plan. The plan is intended to divert garbage from landfill by adhering to the waste hierarchy of avoidance, minimisation, and recycling. RMIT's waste profile includes operating waste from collection locations on campus as well as construction and demolition debris from projects. Throughout the year, data is collected from numerous contractors. RMIT's operational waste contractor provides information on waste to landfill, mixed recycling, paper/cardboard, and organic waste from all on-campus locations. Confidential paper waste is collected separately from operational garbage. RMIT operations in Australia generated 498 tonnes of garbage in 2020, with a diversion rate of 23.1%. The whole waste profile was 60% lower than in 2019. RMIT has begun rolling out the three-bin system in office areas across all campuses (including the removal of under-desk bins). The removal of under-desk bins enhances recycling rates and reduces the usage of plastic bin liners dramatically. The same system is used in communal spaces and kitchens for general garbage (landfill) and mixed recycling, with paper and cardboard deployed to printer and utility facilities. RMIT currently has mechanisms in place for the waste streams of batteries, fluorescent tubes, e-waste, toner cartridges, and furniture.

A summary of the sustainability initiatives at the six selected Australian universities under the category of 'resource and waste management' is presented in Table 6.

Table 6. Summary of initiatives at the six selected universities under the category of 'resource and waste management'.

University of Tasmania	Re-Use program allowed unwanted furniture to be re-used Encouraging resource recovery and recycling through a Resource Recovery Program Pilot recycling wall set up on Sandy Bay campus in 2019 for difficult to recycle items with expansion in more campuses Waste data and material resource use collected and published SIPS resource and waste management related projects conducted
Charles Sturt University	Green labs program that reduces purchasing of material goods and cut down waste production Waste reduction program that converts organic waste to compost Encouraging contractors to reuse and recycle waste e.g., furniture when renovating Laptop equity program helping to divert laptops from landfills
University of Melbourne	Regular waste audits conducted to understand composition of their waste sent to landfills The University complies with government obligations relating to waste and develops strategy in alignment and collaboration with key stakeholders Expanding their waste program to include recovery of all equipment and furniture Maximising recycling rate by enhancing bin placement and labelling

Table 6. *Cont.*

University of New South Wales	Plastic free dining at campuses with 100% single use compostable packaging New furniture reuse portal established, allowing furniture to be stored when not required and made available to any unit Three-bin system introduced to outdoor areas to capture food waste, drink containers and general waste
Monash University	A 20% reduction in total waste to landfill per FTE + EFTSL in 2020, compared to 2015 levels (tonnes / EFTSL + FTE). 50% of the University's total waste recycled in 2020 Second-hand furniture available for sale at Reuse Centre 100% recycled content and carbon-neutral certification paper to be purchased
RMIT University	Published a Waste Management Plan with waste profile and an action plan Implemented a three-bin system Process in place for recycling batteries, toner cartridges, furniture, etc.

3.1.7. Transport

Sustainable transportation is defined generically as transportation that prevents or minimises negative environmental effects and the depletion of natural resources, while also taking into account social justice, community health, and economic development. As part of the efforts to reduce scope 3 emissions, this emphasis area encompasses how people travel to and around campuses, as well as how employees and students travel for university purposes.

UTAS has created the Sustainable Transport Strategy, which includes information on transportation patterns within the university community as well as a five-year plan for more sustainable transportation practises and outcomes. The strategy applies to all UTAS sites and facilities, and it tackles transportation challenges for the whole UTAS community, including students, faculty, staff, and visitors. The sustainable team at UTAS coordinates a biannual Travel Behaviour Survey to collect information on the university community's travel behaviour and patterns across all campuses and facilities. The university is committed to assisting employees and students in selecting sustainable transportation methods to access UTAS facilities, including carpooling, car sharing, public transportation, electric cars and bicycles, cycling, walking, and virtual transportation.

Twin bay EV charging stations for charging two vehicles were built on Charles Sturt University's Port Macquarie Campus in 2020. Prior to the conclusion of this project, the university did not have any EV charging infrastructure established on any of its campuses, which hampered fleet's adoption of EVs as a critical component of a Clean Transportation Plan under the Clean Energy Strategy. This project enables Charles Sturt University to be a leader in the adoption of EVs throughout regional Australia, while also preparing the university to meet the changing needs of staff, students, and other campus users as they embrace the vehicles for personal use. Charles Sturt automobiles were responsible for 1232 tonnes of carbon emissions in 2018. Through the use of renewable energy to charge the vehicles, the transition to EVs will allow this amount to be reduced to zero over time.

Reducing vehicle fleet emissions is an important aspect of the University of Melbourne's broader commitment to sustainability. Since 2007, the university has used Greenfleet to offset all motor vehicle carbon emissions. Initiatives such as the adoption of a pool car system and recommendations for environmentally friendly vehicles have aided in the reduction of fleet size. The timely adoption of sustainable vehicle solutions such as hybrid and electric vehicles are also being encouraged. Air travel by university workers is anticipated to be the second largest source of carbon emissions, amounting to 60,000 tonnes in 2015. Reporting air travel through a travel management system and providing alternatives such as high-quality teleconferencing services are some of the efforts being taken to

reduce air travel, with leftover emissions being offset gradually. Pedestrian and bicycle transportation as well as end-of-trip facilities are being prioritised as a strategic priority across campuses.

The L3 Kingsford Light Rail Line, which arrived in 2020, was welcomed by UNSW. Light rail is one of the most important pieces of infrastructure to benefit the university in its 70-year history, providing a high-capacity, clean, dependable, and sustainable transportation option for staff and students. Light rail now serves the upper and lower ends of UNSW's Kensington campus in conjunction with the L2 Randwick Line, which debuted in 2019. Transport for NSW announced the installation of pop-up cycleways on Todman Avenue, Kensington, and High Street, Randwick, providing a safe alternative to taking public transportation or driving during the COVID-19 pandemic. For many years, UNSW has campaigned for separated cycleways in the local area, notably on High Street, and welcomed the new cycleway, which opened on 21 April 2021. The institution has set a goal of reducing air travel emissions by 1% by 2022 and increasing the ratio of employees and students who commute by active modes to 20%.

Monash University's integrated campus access strategy intends to reduce GHG emissions related with campus mobility by shifting away from single-occupancy automobiles towards sustainable options like public transportation, university shuttle buses, carpooling, walking, and cycling. The university has established an aim of having more than 80% of employees and students using sustainable transportation to commute to Monash campuses by 2030. In 2020, Monash University replaced its fixed annual carparking permit system with a dynamic 'pay as you use' (PAYU) virtual parking system. PAYU parking facilitates a more flexible work and study arrangement. This new technology provides additional choice for staff and students to select their method of transportation on a daily basis, as well as to incentivise those who opt to use sustainable transportation. The virtual parking system's data insights will also be important for future transportation planning. The university's priority areas also include continuing campus pedestrianisation and campaigning for improved pedestrian safety around campuses, increasing the number, quality, and sustainability of transportation services used to connect between campuses, and considering opportunities to reduce transport emissions across the university.

RMIT generates a considerable amount of travel, with 50,000 staff and students travelling practically every day for business and education in a typical year. The Integrated Sustainable Mobility Plan offers the structure to enable and incentivise more employees and students to walk, ride, and utilise public transportation, and guides RMIT's approach to sustainable transport. To encourage students and staff to bike to campus, the university provides a variety of high-quality bicycle infrastructure options. Features include secure bike parking, complete change facilities, and a large number of bike hoops available on all onshore campuses. RMIT encourages new employees and students to cycle by hosting a series of bike workshops throughout the year, which are led by student clubs and other providers. RMIT also sponsors important cycling events throughout the year, such as Ride to Uni Day.

A summary of sustainability initiatives at the six selected Australian universities under the category of 'transport' is presented in Table 7.

Table 7. Summary of initiatives at the six selected universities under the category of 'transport'.

University of Tasmania	Encouraging carpooling, public transport, electric vehicles, cycling, walking Adding more electric charging spots Collecting sustainable transport data through travel behaviour survey, monitoring and reporting key indicators in their Sustainable Transport strategy SIPS transport related projects conducted

Table 7. *Cont.*

Charles Sturt University	Planning to drop transport costs through electric vehicles Electric vehicle charging stations created in 2020 under the clean transportation plan
University of Melbourne	Reporting air travel emissions and investigating opportunities to reduce air travel Providing greater sustainable transport choices for students, staff and visitors Prioritising pedestrian and bike transits Reviewing university fleet vehicles policies to promote hybrid/electric vehicles
University of New South Wales	Light Rail L3 Kingsford Line opened for an easy and sustainable transport option New pop-up cycle way introduced for a safe option Planning to reduce air travel emissions by 1% by 2022 and increase the percentage of staff and students commuting by active travel modes to 20%
Monash University	Goal of at least 80% of staff and students to use sustainable transportation by 2030 Introduction of PAYU virtual parking system in 2020 Advocating for improved pedestrian safety around campuses Continue exploring opportunities to reduce transport emissions
RMIT University	Developed Integrated Sustainable Mobility Plan for sustainable transportation to and from campus Free secure bike parking and facilities available at all campuses Bike workshops conducted for staff and students

3.1.8. Water

Water is a limited natural resource. Australia has frequent droughts that result in severe reductions in water storage in its enormous lakes and waterways. The goal of sustainable water management is to ensure the availability of high-quality water in the future.

UTAS is made up of a diverse community of employees, students, contractors, and visitors. Water is used in a variety of activities by all groups, including everyday requirements, cleaning, and research. In addition, all schools' landscapes (including athletic fields) require watering. The university is dedicated to reducing water usage and pollution, as evidenced by many documents such as its sustainability policy and chemical management procedure. UTAS currently has water harvesting and water efficiency infrastructure in place across its three campuses, including rainwater tanks at Newnham and Inveresk campuses and dual-flush toilets and low flush urinals in many buildings, and has been installing water-efficient fittings in all new buildings since 2009. Water harvesting capacity and water efficiency are expected to grow further in the coming years as a result of infrastructural enhancements and behaviour change activities.

Overall, Charles Sturt municipality water use in 2020 was 31% lower than in 2019. To continue conserving water specific internal interventions were implemented, such as water conservation signage and an education campaign that was rolled out across all campuses, an audit of town water leaks, the elimination of town water for farm use, the minimisation of town water for irrigating turf and grounds including the installation of irrigation controllers, and specific irrigated turf-reduction projects that are expected to have long-term benefits. The task for Charles Sturt in the coming years is to maintain the lower consumption attained in 2020.

The University of Melbourne is a major water user in Melbourne, consuming 447,000 kilolitres of mains water in 2015. Priority actions include completing the annual report and reviewing the Water Management Plan for each campus, commissioning the existing Parkville purple pipe network to enable the use of harvested water, and implementing infrastructure to monitor all harvested water usage. The university has obligations to

water authorities and is an active participant in voluntary collaboration programmes and initiatives as a significant stakeholder. The university aims to cut mains water usage per floor area by 12% by 2020, representing a 40% drop from their original baseline in 2006.

UNSW intends to significantly boost water-use efficiency across all sectors while ensuring sustainable withdrawals and supply of fresh water in order to address water shortage and significantly reduce the number of people suffering from it by 2030. Water efficiency is also expected to rise by 2% per EFTSL by 2022. Furthermore, the university is committed to reducing potable water consumption and returning water to the hydrological cycle. Reduced campus activities in 2020 resulted in a decline in water use by 45%, which enhanced water target performance after falling short in 2019.

Monash University's water management plan prioritises water conservation, water harvesting, and community awareness. The university's overall potable water use decreased by 22% in 2019–20 compared to 2018–19. As part of the university's water management project the final parts of the Clayton campus collected water ring main and the biofilter bypass filtration system were commissioned in 2020. This involved installing smart metering on the largest stormwater harvesting systems to ensure optimal utilisation and to improve data collection and quality. As part of the university's Urban Space Maintenance contract, a water conservation incentive programme and a specialised manager for non-potable water systems were also developed.

RMIT is dedicated to reducing water use intensity across campus by focusing on water efficiency, harvesting, and reuse. In the "RMIT Design Standards" document, RMIT prioritises water efficiency by establishing minimum standards for fixtures and fittings, supporting water capture and storage, and incorporating water sensitive urban design in landscaping [38]. The institution has 40 smart meter devices deployed throughout its building portfolio, providing visibility into consumption characteristics. In addition to the smart meter gadgets, RMIT has 1.3 million litres of on-site storage tanks, which reduces the need for potable water usage. The on-site storage enables the collection of rainwater and stormwater, which is often used for toilet flushing or irrigation. RMIT collects stormwater in natural basins on the Bundoora Campus, and when the water levels are high enough the extra water is used in cooling tower applications on campus. As part of the university's reaction to COVID-19 in minimising the number of touch points in high traffic areas, RMIT added a total of 524 sensors to existing bathroom taps in 2020. This project also lowered potable water use because the more efficient taps were turned on for shorter periods of time.

A summary of sustainability initiatives at the six selected Australian universities under the category of 'water' is presented in Table 8.

Table 8. Summary of initiatives at the six selected universities under the category of 'water'.

University of Tasmania	Water harvesting and water efficient infrastructure across all campuses including rainwater tanks, dual flush toilets and water efficient fittings Water consumption and wastewater data collected SIPS water related projects conducted
Charles Sturt University	Water conservation signage and education campaign rolled out in all campuses Audits and minimisation of town water done
University of Melbourne	The university has obligations to water authorities and participates actively as a key stakeholder in voluntary collaborative programs and initiatives Implementing infrastructure to monitor all harvested water usage
University of New South Wales	Commitment to reduce potable water use and return water to the hydrological cycle Planning to Increase water efficiency per EFTSL by 2% by 2022

Table 8. *Cont.*

Monash University	22% decrease in potable water for 2019–20 Commissioning of a harvested water ring main and biofilter bypass filtration system completed Smart metering on stormwater harvesting systems installed Establishment of a water conservation incentive program done
RMIT University	Installed water efficient appliances on campuses Total capacity of 1.3 million litres of on-site storage tanks, reducing requirements for potable water usage Over 40 smart meter devices installed across campuses to give real time access to water consumption Water harvesting initiatives undertaken

3.2. Sustainability at Universities Outside Australia

As more universities around the world have pledged to be carbon neutral, this subsection will briefly look at the goals and strategies from some leading universities outside Australia. As this study focusses on sustainability initiatives towards carbon neutrality in Australian universities, the authors would like to point out that the universities discussed in this sub-section are only a snapshot in the context of universities outside Australia that are leading in sustainability and achieving carbon neutrality.

In North America, The University at Buffalo (UB), the largest public university in New York, has pledged to minimise GHG emissions and to serve as a leader in the worldwide climate change mitigation campaign. It is worth mentioning that in the Times Higher Education Impact Rankings on Climate Action (SDG 13) for 2021, UB is ranked first in terms of the impact it makes in working towards net zero carbon emissions [39]. Conservation, as demonstrated by the university, can reduce entire campus energy consumption by 30% or more. On March 15, 2007, UB President John B. Simpson signed the American College and University Presidents Climate Commitment (ACUPCC) as part of a broader campaign to elevate UB's standing as an intellectual and economic force for change. This requires the university to not only measure and reduce its GHG emissions, but also to devise and implement strategies to achieve its climate neutrality goal by 2030 [40].

In Canada, the federal government has expressed renewed interest in supporting climate action, and hence universities like the University of British Columbia have dedicated operations to comply with provincial climate legislation. An emissions profile has suggested that the university reduce its usage of natural gas to reach a 2050 target of carbon neutrality [41].

In the United Kingdom, the carbon policy for universities states that "within the next ten years, the higher education sector in this country will be recognised as a major contributor to society's efforts to achieve sustainability through the skills and knowledge that its graduates learn and apply, as well as through its own strategies and operations". Universities such as the University of Nottingham have contributed consistently towards carbon management; this university has also received numerous honours, rising to the top of national and international rankings. A framework to reduce CO_2 emissions and to fulfil university targets towards carbon neutrality by 2028 is also underway [42].

In the Oceania region, the Victoria University of Wellington in New Zealand has a major goal to achieve net zero GHG emissions by 2030. This has allowed the university to be placed in the top 40 universities in the world for its social impact and commitment to the UNSDGs in April 2020, recognising its leadership in this area [43]. The activities that will achieve this goal will also have a positive impact on the community and the university.

4. Discussion

There is no question that universities are at the forefront of achieving carbon neutrality through various sustainability initiatives [44]. With the current push for the phasing out of fossil fuels, employing renewable energy sources, facilitating behavioural change,

increasing energy efficiency, and implementing strategies for achieving carbon neutrality are all essential approaches that need to be implemented across universities.

This study has reviewed the sustainability strategies of six selected universities in Australia that are leading in implementing initiatives to achieve carbon neutrality. It is clear from this review that although some universities stand out with exceptional performance in terms of their initiatives to achieve carbon neutrality, many other universities in the overall university cohort require additional efforts to increase the quality of their initiatives. Sustainability strategies and initiatives at several universities outside Australia were also briefly discussed: the University at Buffalo (New York) in the United States and the University of British Columbia in Canada, which were ranked first and third, respectively, in the 2021 Times Higher Education Impact Rankings on Climate Action [39].

This review has also identified eight sustainability categories to reduce a university's carbon footprint, namely, built environment, energy, food and gardens, GHG emissions, natural environment, resource and waste management, transport, and water. It is worth noting that sustainability initiatives in transport is a category which most higher education institutions in Australia have started to implement. Sustainable campus practices in the selected universities were discussed under the eight sustainability categories in order to elicit the importance of envisioning and implementing sustainable practises in all parts of campus life. As mentioned earlier in the paper, Charles Sturt University and UTAS are Australia's only certified carbon neutral universities. Although Charles Sturt University was the first university to be certified as carbon neutral, there is not very much publicly available information on the university's journey to carbon neutrality or documenting and maintaining its carbon neutral status. Reporting activities publicly is imperative for carbon neutrality, as demonstrated by the Climate Active Carbon Neutral Standard. As a result, not only can this help maintain carbon neutrality, it can also act as an incentive for other higher education institutions to improve their sustainability efforts. On the other hand, UTAS has facilitated public engagement in their sustainability initiatives through a variety of platforms. All important information about sustainability initiatives at UTAS can be found via a user-friendly sustainability portal. More detailed information may also be found in the publications which have been made accessible through this online portal. The university also has a sustainability podcast series created by their Sustainability Integration Program for Students (SIPS) that features interviews with staff and students at UTAS. As one current initiative, the university is committing to divesting from fossil fuel-based investment funds by the end of 2021, as reflected in the relevant university policies, strategies, and procedures. Thus, this study has identified UTAS as a university with sustainability initiatives, strategies and research that can pave the way for similar climate action at other universities in Australia and elsewhere.

An interesting finding of this review is the way in which universities are implementing sustainability initiatives in line with their mission and values. Despite striving towards the same end goal of achieving carbon neutrality, different institutions offer individually unique approaches towards sustainability. UTAS values the creation, expansion and dissemination of knowledge and the promotion of continual learning which is clearly demonstrated through their initiatives and policies. Similarly, each university has tailored its initiatives according to the environment in which it operates. For example, a comparison can be made between the approach by UTAS to water in Tasmania, where there is an apparent abundance of fresh water, and Charles Sturt University's commitment in regional New South Wales, where fresh water is scarce.

It is also worth discussing that, according to recent research, the COVID-19 epidemic has resulted in decreased carbon emissions, as evidenced by data collected through questionnaires [45]. Universities in Australia have also reported significant decreases in their emissions due to the COVID-19 pandemic, which suggests that universities and university teaching can be reinvented to be more sustainable. Researchers have also suggested that the digitalisation of higher education in light of sustainability and in times of the COVID-19 pandemic is highly recommended [46].

This study has clearly identified how some of the leading universities in Australia are working in alignment with the UNSDGs for a more sustainable future.

5. Conclusions

According to the research findings of this review, higher education institutions seek to prioritise the efficient use of natural resources throughout the educational process as well as to ensure a balanced, fair, and integrated socioeconomic development through teaching, research, and good governance, not only for their staff but also for the broader community. Although there are barriers to achieving sustainability goals and carbon neutrality, various universities have adopted transformational plans that aim to provide leadership through sustainability strategies and practises. Based on the case studies of selected universities that are leading in their efforts to achieve carbon neutrality, it is recommended that universities develop long-term strategic approaches towards this critical area to stimulate, implement, and develop sustainability strategies. Using case studies of universities that are leading in making an impact through their sustainability strategies and/or have already achieved carbon neutrality, this research has provided guidelines, particularly to Australian universities, on how similar strategies, initiatives and policies can be identified and implemented by universities that are nearing carbon neutrality or wish to achieve it the future. Implementing such initiatives in all the sustainability categories identified in this review is critical to achieving carbon neutrality.

This study also indicates that the contributions presented in this review may be limited, as not all universities in Australia and outside Australia were evaluated; however, readers can gain an overview by analysing the current research findings to understand how universities can contribute to mitigating climate change and achieving carbon neutrality. It would be relevant to further examine how Australian universities contribute to the UNSDGs at the international level. There are great prospects for comparing sustainability initiatives at higher education institutions nationally in Australia as well as globally in order to gain deeper insights from their experiences.

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