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# Net-Zero Heroes? Climate Change Mitigation Efforts and Strategies across Australian Group-of-Eight Universities

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**Abstract:** Businesses are increasingly declaring their operations to be "carbon neutral" or "net-zero". But how real are these claims? We investigated the climate mitigation efforts of the eight leading universities in Australia and discovered that the actual emission reductions lag behind the net-zero rhetoric. In the last ten years, most universities increased energy consumption, while reported emissions plateaued. The energy consumption and greenhouse gas emissions of Group-of-Eight (Go8) universities were influenced by size and population growth, climate of the campus location, and energy efficiencies. The Go8 universities experienced, on average, a 25% increase in student numbers in the last decade, and most increased their energy consumption. However, Scope 1 (direct emissions) and Scope 2 (emissions from electricity consumption) remained stable for most universities from 2011 to 2019 and decreased on a per-capita basis, indicating some level of improved efficiencies. Almost all Go8 universities have net-zero commitments and aim to achieve this by similar measures: power purchase agreements (PPAs) for electricity consumption, and carbon offsets for remaining emissions. Most universities lack a strategy for direct or measurable targets regarding energy or emissions reductions along their value chain. Unlike the UK or other countries, Australia has no standardised emission reporting requirements for Scope 3 emissions (other indirect emissions). This has led to rudimentary and haphazard reporting, limiting comparability between universities. Only one university had a more complete Scope 3 inventory, and these Scope 3 emissions were five times greater than their combined Scope 1 and 2 emissions, indicating a potential for substantial under-reporting of emissions. This highlights the need for more rigorous, consistent, and sector-specific emissions accounting, especially on indirect emissions, and for an overhaul of net-zero accreditation.

**Keywords:** $CO_2$e emissions; emissions reporting; energy consumption; greenhouse gas emissions; GHG emissions; carbon footprint; emissions inventory; direct and indirect emissions; carbon offsets; power purchase agreement; HEI; universities



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## 1. Introduction

The impetus to mitigate the worst effects of climate change is growing as rising global temperatures continue to increase the frequency and voracity of natural disasters across the globe. To keep within the 1.5 °C Paris target, we must halve global carbon emissions by 2030 and hit net-zero emissions by 2050 [1]. In response, thousands of corporate leaders, businesses, and institutions are vouching to do their part to reduce emissions in line with limiting global warming to 1.5 °C [2,3].

Within corporate actors, higher educational institutions (HEI, referred hereon as universities) face some of the highest public expectations for net-zero strategies, since they are often funded by public money, educate younger generations, and have the capacity to influence climate change responses through their research, education, and operations [4–6]. Top-tier universities consider themselves global leaders in driving change within policy and practice. Common statements among them include, for example: "As a national leader in climate science and policy, ANU will prioritise sustainability as a principle" [7] or "If Monash University is to be an international leader driving change towards sustainability, [. . .] it needs to be seen as a leader in the adoption and application of the Circular Economy" [8]. Globally, many universities have met the spotlight with ambitious targets, including more than one thousand universities pledging to "net-zero emissions" by no later than 2050 [2]. However, commitments alone are not enough without a rapid and robust strategy and checks and balances along the way [9,10].

A well-accepted method for institutions to understand their climate impact is through measuring and reporting their "carbon footprint", "greenhouse gas (GHG) emissions", or "emissions inventory" [6,11,12]. In all cases, this involves adding the GHG emissions for which an institution is responsible and standardising the different GHG gases under a common metric of carbon dioxide equivalent ($CO_2$e) [13]. The methodology is well established for Scope 1 emissions (direct emissions, which primarily consist of gas burning and fleet vehicle exhaust) and Scope 2 emissions (emissions associated with purchased electricity) [14,15]. However, there is increasing focus on value chain emissions—Scope 3 emissions—for which a corporation must also claim some level of responsibility [4,16]. This includes emissions associated with purchased goods and materials, travel (e.g., business flights and commuting), waste (landfill emissions), and investments [17]. The suggestion that Scope 3 emissions are a material responsibility for institutions provokes new questions around emissions boundaries, reporting obligations, and the very meaning of—and validity of claims around—'carbon neutrality' or 'net-zero' emissions.

We investigated the historical timeline of greenhouse gas emissions and future net-zero strategies of the 'Group-of-Eight' (Go8) universities in Australia. The objectives were: (a) to investigate trends in emissions and emissions intensity (per capita and per area), (b) to evaluate the emissions reporting and disclosures of each university, and (c) to analyse each university's net-zero strategy to investigate convergences and divergences in strategies between institutions.

## 2. Materials and Methods

### *2.1. Scope*

To allow for depth of analysis into individual reports, we narrowed the scope to the Group-of-Eight (Go8) [18] universities in Australia: the University of Melbourne (UoM), the Australian National University (ANU), the University of Sydney (UoS), the University of Queensland (UQ), the University of Western Australia (UWA), the University of Adelaide (UoA), Monash University (Mon), and the University of New South Wales (UNSW). The Go8 were selected from within the greater Australian university sector due to their comparability, coverage across multiple geographies, and significant economic, political, and sectoral influence. They educate over 380,000 students (more than one-quarter of all higher-education students in Australia), employ over 50,000 staff, and have an associated economic impact of over AUD 66 billion, about 4% of the total GDP [19]. Referring to themselves as "a leader in . . . the development and delivery of long-term sustainable national higher education and research policy" [18], the Go8 are significant influencers in setting the standard for climate strategies and disclosures in higher education.

### *2.2. Greenhouse Gas Emissions Data*

For six of the eight universities, annual Scope 1 and 2 emissions since 2010–2011 were available through the Clean Energy Regulator (CER) through the National Greenhouse and Energy Reporting (NGER) Act 2007 [20]. This act requires facilities with annual emissions over 25 kt $CO_2$e or annual energy consumption over 100 TJ to report their consumption and Scope 1 and 2 emissions under a single national framework [21]. Under the Act, data for entities with emissions above 50 kt $CO_2$e are summarised into a single, annual table to be made publicly available. In the case of the Go8, while all eight universities are above the reporting threshold and must report through the NGER Act, only six exceed the 50 kt $CO_2$e threshold and were added to the CER's summary tables. We contacted sustainability officers of the missing universities (UoA and UWA) to supply their annual emissions disclosures under the NGER Act, as well as ANU who was erroneously missing from the 2020–2021 government data.

*2.3. Emission Intensity Metrics*

To better reflect differences in campus size, we sourced population and area metrics to create per-capita and per-area calculations of emissions. Annual population data were sourced from the Department of Education Skills and Employment [22] through combining the equivalent full-time student load (EFTSL) and staff full-time equivalent (FTE). Work experience in industry and offshore students were not included in student population metrics, as they were unlikely to visit campuses. The staff metric included the sum of full-time, fractional full-time, and estimated casual staff.

Energy (GJ $m^{-2}$) and emissions intensity (kg $CO_2$e $m^{-2}$) are common metrics to assess average energy/emissions per unit of area. To calculate it, we divided energy consumption and Scope 1 and 2 emissions data sourced through the Clear Energy Regulator by gross floor area (GFA), defined as the "total floor area inside the building envelope" [23]. GFA is calculated and provided by all Go8 universities to the Tertiary Education Facilities Management Association (TEFMA), a professional association for university property and facilities managers. However, GFA data could not be obtained from TEFMA, as it is made available only to financial members and anonymised to be used for internal benchmarking. Therefore, GFA data had to be sourced from Go8 universities individually.

GFA includes rooms, halls, floored roofs, basements, attics, covered car parks, lift shafts, garages, staircases, roofed balconies and verandas, and open covered ways. Considering that many of these spaces are unlikely to use energy beyond lighting, the metric is arguably overly inclusive in accepted floorspace. While fully enclosed covered area (FECA) as a denominator would have been a preferable metric, these data were not as readily available across universities, so GFA was deemed the best option. Five universities (ANU, UoM, UWA, UQ, and UoA) provided us with GFA data, as submitted within their most recent TEFMA report. GFA was also available for two universities (UoS and UQ) who participate in the Sustainability Tracking, Assessment, and Rating System (STARS) reporting tool. For universities that did not respond/data could not be sourced, GFA was estimated by finding pre-published energy intensities (GJ $m^{-2}$) and dividing equivalent annual NGER data by these values (UNSW and Mon). We used 2019 NGER data to reflect pre-pandemic consumption and GHG emissions. Due to limited access and responses from universities, we mapped 2019 NGER data to GFA values related to years between 2019 and 2021, so some imprecisions are expected in the values due to possible changes in floor area over these two subsequent years.

*2.4. Timeline Inconsistencies*

We noted a 6-month discrepancy between datasets due to the Department of Education Skills and Employment using an academic calendar (1 January YYYY to 31 December YYYY), while the Clean Energy Regulator reports emissions using the financial calendar (1 July YYYY to 30 June YYYY+1). Data were merged so that a single year, for example 2018, corresponds to Academic Year 2018 and Financial Year 2017–2018.

*2.5. Voluntary Greenhouse Gas Emission Disclosures*

Unlike NGER data, which only account for Scope 1 and 2 emissions, voluntary university emissions disclosures often include aspects of their Scope 3 emissions. We evaluated each university's annual report, sustainability reports, and third-party reports for Scope 1–3 emissions reporting. Accordingly, we included data from sustainability/emissions reports (Adelaide, ANU, UoM, UNSW, and UWA), annual reports (Mon), and STARS disclosures (UoS and UQ). Each type of Scope 3 emissions (e.g., business flights, waste, and investments) were recorded and grouped.

## 3. Results

### *3.1. Greenhouse Gas Emissions*

The Go8 universities can be separated into two distinct groups based on their size: five larger universities with annual populations (EFTSL + FTE) between 50,000 and 65,000, and three smaller institutions with annual populations between 20,000 and 30,000 (Figure 1a). This correlates to the location of the primary campus in a larger metropolitan centre (Mon and UoM in Melbourne, UoS and UNSW in Sydney, and UQ in Brisbane) or smaller capital cities (UoA in Adelaide, UWA in Perth, and ANU in Canberra). All Go8 universities, except for UWA, have experienced population growth over the past decade: on average, campus populations have increased from a mean of 36,456 in 2011 to 46,967 in 2019 (an annual growth of 3.6%). The largest increases were at UoM, Mon, and ANU (over 30%), followed by the two Sydney universities (around 25%), and the smallest increases were at UQ and UoA (around 10%). Populations decreased in 2020 in line with the COVID-19 pandemic, which was particularly noticeable for the universities Mon, UoM, UNSW, and ANU.

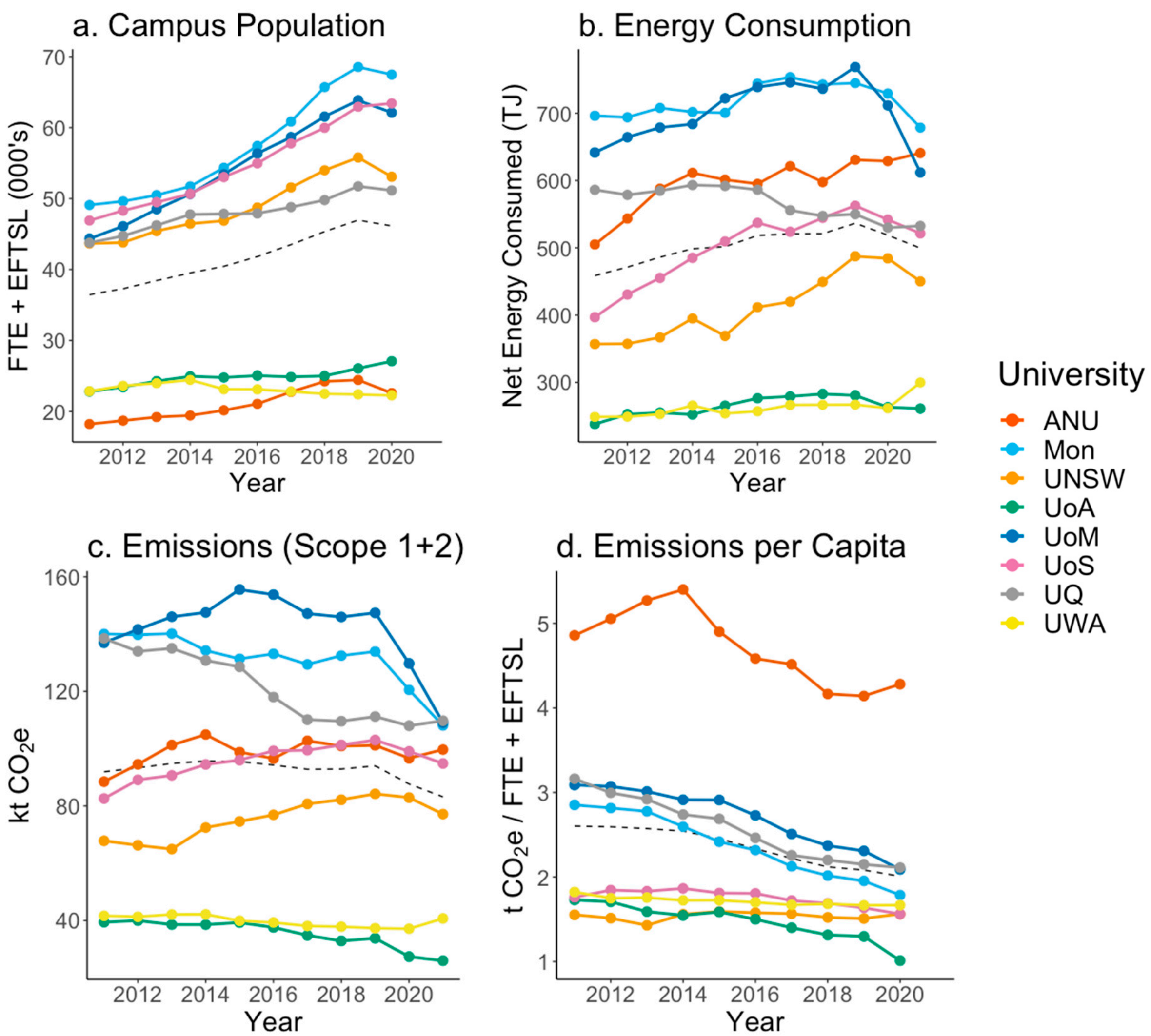


**Figure 1.** (**a**) Campus population, (**b**) net energy consumption, (**c**) greenhouse gas emissions, and (**d**) GHG emissions per capita for Group-of-Eight universities in Australia in the period from 2011 to 2021. (**a**) Campus population, as student effective full-time load (EFTLS) and staff full-time equivalent (FTE). (**b**) Energy consumption in TJ. (**c**) GHG emissions from Scope 1 and 2 in kt $CO_2$e. (**d**) GHG emissions per capita in t$CO_2$e divided by campus population. Each university is presented in a different colour, and mean values of all eight universities are in dotted grey.

The average energy consumption of Australian Go8 universities increased annually by 2% between 2011 and 2019 (Figure 1b). Between 2011 and 2019, UoS and UNSW increased net energy consumption by around 40%, UoM, UoA, and ANU increased by around 20%, whereas UQ was the only university that had a decrease in net energy consumption before the pandemic. Reduced energy consumption during the pandemic years was also not consistent among the universities. Some universities had much greater decreases (UoM, Mon, UoS, and UNSW) than others (UoA), and some universities had no change (UQ).

In comparison, average Scope 1 and 2 $CO_2$e emissions effectively plateaued between 2011 and 2019 among all universities (Figure 1c). However, we again observed differences among universities: those that had increases in energy consumption also showed increases in $CO_2$e emissions (~25% increase for UoS and UNSW, and 15% for ANU), and only three universities had reductions in $CO_2$e emissions in that period (−20% for UQ, −14% for UoA, and −4% for Mon). In the pandemic years, emissions declined, on average, by 15% in just two years.

Average per-capita emissions of the Go8 universities decreased from 2.60 t$CO_2$e per capita in 2011 to 2.08 t$CO_2$e in 2019: a 20% decrease over eight years (Figure 1d). UoA, UoS, UNSW, and UWA had the lowest emissions per capita (1.3–1.6 t$CO_2$e in 2019), UoM, Mon, and UQ had per-capita emissions of around 2.0–2.3 t$CO_2$e in 2019, and ANU was the major outlier (4.3 t$CO_2$e per capita in 2019). ANU's 2019 value is nearly three times greater than the average of the other universities and nearly five times greater than the smallest per-capita emitter, UoA.

Energy consumption and $CO_2$e emissions of the Go8 universities were closely correlated (Figure 2a), whereby 92% of the variance in annual emissions could be explained by energy consumption. The figure also illuminates the effects of changing state-level emission factors. Vertical drops are visible for UQ (grey) and UoA (green) during years where their state-level electricity emission factors also drastically decreased.

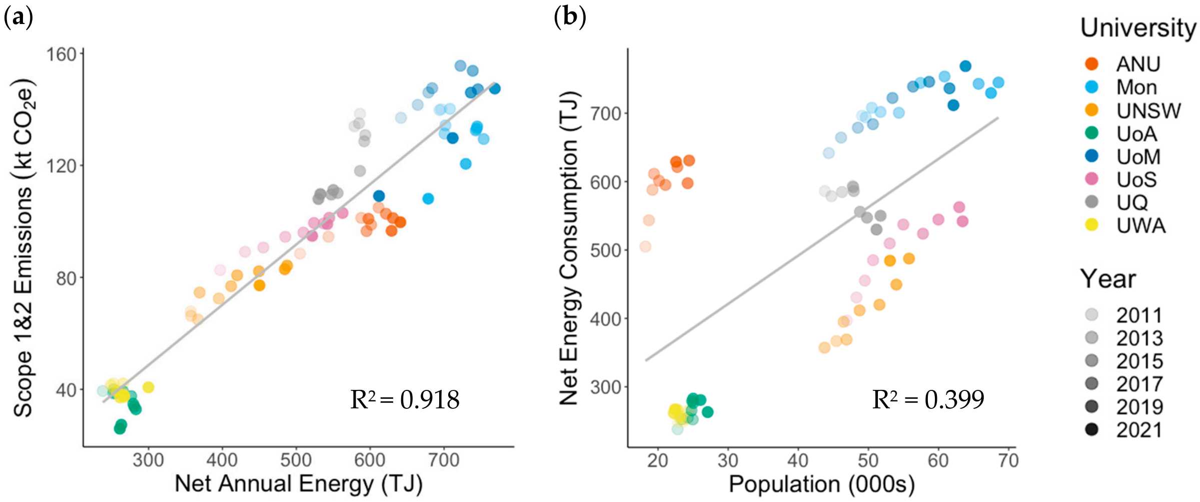


**Figure 2.** Relationship between (**a**) annual net energy consumed (TJ) and Scope 1 and 2 emissions (t $CO_2$e), and (**b**) net energy consumed (TJ) and campus population (staff and students), as reported through the NGER Act by Australian Group-of-Eight universities from 2011 to 2021.

Population size of universities was weakly correlated with energy consumption (Figure 2b). The universities in the colder climates (ANU, UoM, and Mon) had greater net energy consumption compared to the universities in warmer climates. Most universities had a linear relationship between population size and energy consumption. Exceptions were UoA, UQ, and ANU, which indicated some level of energy efficiency with increasing population size.

A second common benchmark to compare energy consumption and GHG emissions across different sized institutions are emissions per area. Figure 3 illustrates energy (square) and emissions (cross) intensities across the Go8 in 2019. Most universities had similar energy intensities of around 0.7 GJ $m^{-2}$.

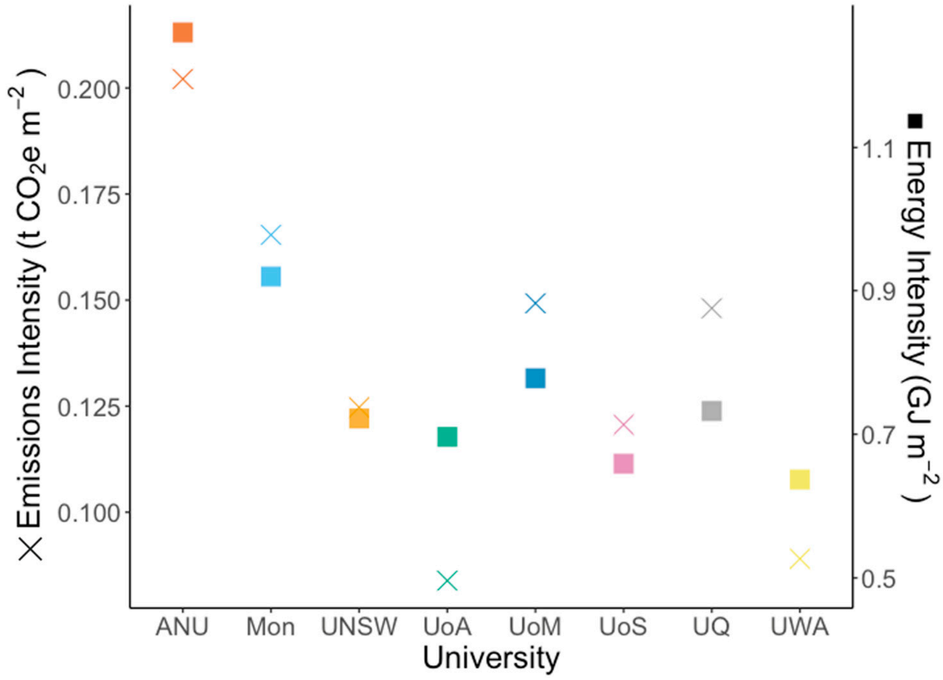


**Figure 3.** Emissions intensity (t $CO_2$e $m^{-2}$, crosses) and energy intensity (GJ $m^{-2}$, squares) of the gross floor area of Group-of-Eight universities in Australia in 2019. Universities are displayed in different colours and ranked alphabetically. Mean values of energy and emissions intensities for each university are displayed in the graph.

ANU remained the Go8 university with the highest emissions intensity per gross floor area (GFA); however, the extent was less pronounced compared to campus population as a benchmark (Figure 1d). There was a positive relationship between gross floor area (GFA) and campus population among the Go8 universities: universities with a greater population also occupied a greater area.

### *3.2. University Emissions Reporting and Disclosures*

Australian universities create their own emissions inventories and many report on Scope 1, 2, and 3 emissions voluntarily. Figure 4 highlights inconsistencies between mandatory and voluntarily reported Scope 1 and 2 emissions. While the Australian National Greenhouse and Energy Reporting scheme (NGER) and voluntary reports were consistent for Scope 1 emissions, Scope 2 emissions exhibited differences; notably, ANU's Scope 2 emissions (83,961 t$CO_2$e NGER versus 1621 t$CO_2$e in ANU reports). This is because ANU has elected to only present "market-based" rather than "location-based" emissions accounting, allocating zero emissions to all electricity consumed within its territory due to the ACT government having signed power purchase agreements with renewable power generators across the country. In the case of UoS, their Scope 1 and 2 emissions displayed within STARS reporting is one-thousandth of their NGER emissions, suggesting they missed three zeros, and the error was not detected by STARS auditors.

Scope 2 emissions (from electricity generation) dominated the overall emissions for most universities, while Scope 1 emissions made up around 10% of Scope 1 and 2 emissions. Universities in cooler areas tended to have a higher proportion of Scope 1 emissions (ANU, Mon, and UoM), while others had almost none (UQ). Three universities had equally high Scope 1 and 2 emissions, with around 130,000 t $CO_2$e (UoM, Mon, and UQ), three universities had Scope 1 and 2 emissions around 100,000 t $CO_2$e (UoS, ANU, and UNSW), and the two smallest universities also had the lowest Scope 1 and 2 emissions, with around 30,000 t $CO_2$e.

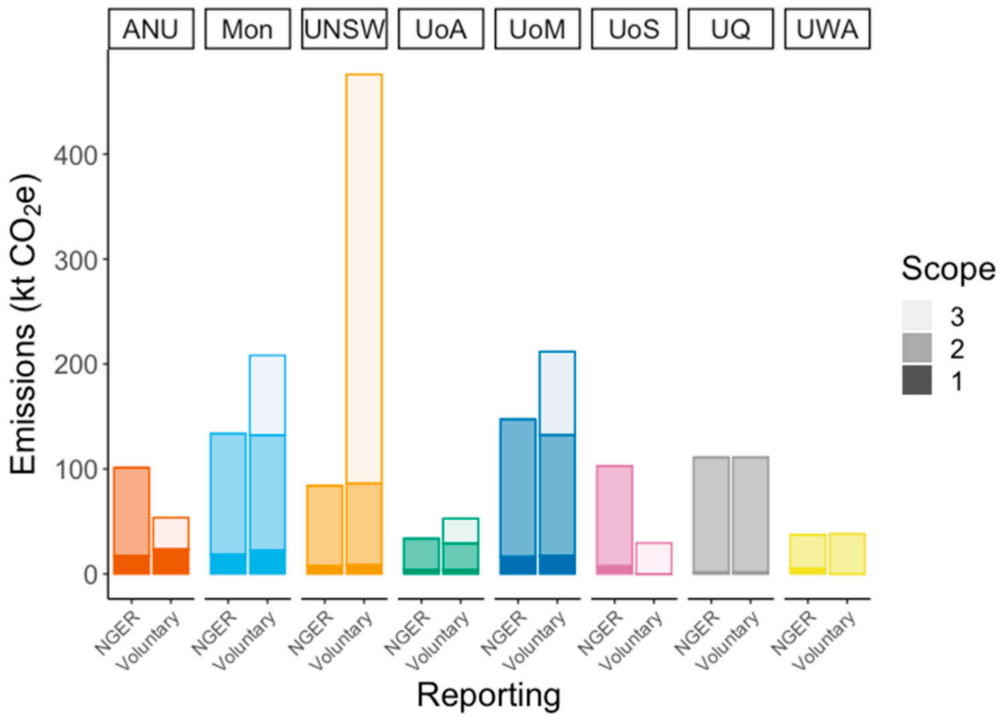


**Figure 4.** Comparison of greenhouse gas emissions of Group-of-Eight universities in 2019, as reported through both the National Greenhouse and Energy Reporting (NGER) Act, and voluntarily through annual reports and/or third parties. Displayed are Scope 1, Scope 2, and Scope 3 emissions (noting that NGER only collects Scope 1 and 2 data).

Scope 3 emissions were disclosed by six of the eight universities, and values ranged by an order of magnitude largely because the universities all used different emissions boundaries (Table 1). All lacked a description of the methodological framework and processes. For example, while UNSW and UoM disclosed that Scope 3 emissions account for "purchased goods and services" or "third-party services", respectively, the extensiveness within these categories and the estimation methodology were not elaborated. At the most developed end was UNSW, which disclosed itemised values for all material emissions within the 15 categories stipulated through the Greenhouse Gas Protocol framework [11]. The consequences of this inconsistent reporting are substantial. UNSW's Scope 3 emissions were five times greater than its combined Scope 1 and 2 emissions. Meanwhile, despite ANU and UoS having higher Scope 1 and 2 emissions than UNSW, both reported less than 10% the Scope 3 emissions of UNSW.

### *3.3. Net-Zero Targets and Plans*

All Go8 universities have announced an emissions target in line with science-based targets of net-zero emissions no later than 2050 (Table 2). In terms of the target year, UNSW has the most ambitious plan and has outlined Scope 1, 2, and 3 emission reduction targets of 30%, 50%, and net-zero by 2025, 2030, and 2050, respectively. The least ambitious is UoA, which has not committed to carbon neutrality (of Scope 1 and 2) until 2050. The remaining six universities have set net-zero targets between 2025 and 2030, of which UoM and UQ state will include some Scope 3 emissions but have not defined their emissions boundary.

**Table 1.** Inclusions in Scope 3 emissions inventories of Group-of-Eight universities in Australia in 2019. Dark shaded cells indicate inclusion of a Scope 3 emission in the reporting (also indicted by a 'Y'), open cells (with a 'N') indicate that this item was not included, and a light grey cell indicates that an item was partly included.

| Scope 3 Inclusions | ANU | Mon | UNSW | UoA | UoM | UoS | UQ | UWA |
|---|---|---|---|---|---|---|---|---|
| Business Flights | Y | Y | Y | Y | Y | Y | N | N |
| Employee Commuting | N | N | Y | Y | Y | N | N | N |
| Student Commuting | N | N | N | N | N | N | N | N |
| Waste Disposal | Y | Y | Y | Y | Y | Y | N | N |
| Upstream Energy Losses | N | Y | Y | Y | Y | N | N | N |
| Purchased Goods and Services | N | Paper, Water | Y | N | "Third-party services" | Water | N | N |
| Other | N | N | Capital goods; fuel- and energy-related activities; up- and down-stream transportation; use and disposal of sold products; leased assets; investments. | N | "Equipment" | N | N | N |

**Table 2.** Decarbonisation strategies related to carbon neutrality target years, renewables uptake, and absolute emissions reductions in Group-of-Eight universities, as of September 2022.

| | ANU | Mon | UNSW | UoA | UoM | UoS | UQ | UWA |
|---|---|---|---|---|---|---|---|---|
| Net-Zero Target (Scope 1+2) | 2025 | 2030 | 2020 (S1+2) 2050 (S1–3) | 2050 | 2025 (Including some S3) | 2030 | 2025 (Including some S3) | 2025 |
| Net-Zero Strategy? | PARTIAL: Below-Zero Strategy Development | YES: Net-Zero Initiative; Decarbonisation Roadmap | CEASED: Sustainability Plan (Expired 2021) | CEASED: Sustainability Plan (Expired 2020) | YES: Sustainability Plan 2030 | YES: Sustainability Strategy 2020 | YES: 2021–2025 Sustainability Strategy | YES: Sustainability Strategy 2020 |
| Current on-site renewables capacity | Estimated 0.15 kW | 4.1 MW | 1.2 MW | 1.85 MW (2.1% of TEC in 2020) | Estimated 2.5 MW (1.3% of TEC in 2020) | 1.13 MW (0.71% of TEC in 2020) | 6.31 MW (6.0% of TEC in 2019) | 0.28 MW |
| On-site renewables Target | None announced | 5 MW by 2025; 5.5 by 2030 [1] | None announced | None announced | None announced | 3 MW by 2025 | None announced | 3 MW by 2025 [2] |
| Off-site renewables Target (PPA) | N/A: Under ACT PPA | YES: 55% in 2020; 100% by 2030 | YES: 100% since 2020 | None disclosed | YES: 100% since 2021 | YES: 100% by 2022 | YES: 100% since 2020 | YES: 100% by 2025 |
| Electrification Targets | No | YES | Aim but no targets | No | Aim but no targets | Aim but no targets | YES | No |
| Absolute Emissions Reduction Targets | N/A—No current strategy | 400,000 GJ cap by 2030 (40% reduction from 2017 baseline) | S1–3 reduction of 30% by 2025 and 50% by 2030 | N/A—No current strategy | ~10% annual reduction in electricity consumption [3] | Only S3: 20% reduction in waste, air travel by 2025 | No reduction: consumption maintained below 2019 base | 27%/30% reduction in electricity and gas use by 2025 |

[1] Equivalent to 20% of total energy consumption (TEC) by 2030 (assuming the 40 percent energy reduction target is also met). [2] Equivalent to 10% of TEC by 2025 (assuming the 30 percent energy reduction target is also met). [3] Electricity usage reduction target of 18 to 25 gigawatt hours per annum [24].

As of September 2022, only five of the Go8 universities had current strategies that detail their pathway to net-zero emissions by their target year. UoA and UNSW's strategies expired in 2020 and 2021. UQ and UoM's strategies had expired in 2020 and were only updated in 2021 and 2022, respectively. Both updated strategies were more general in nature than their previous iteration, with a departure away from SMART objectives (Specific, Measurable, Achievable, Relevant, and Time-Bound). Examples include UoM's goal to reduce Scope 3 emissions "wherever possible", or UQ's goal of an "accountable supply chain" without any indicators of performance.

### *3.4. Commitment towards Renewables and Electrification*

While all universities have installed some amount of on-campus solar, no university is close to self-sufficiency, with the top-performing university (UQ) still relying on grid electricity for 94% of its energy needs. Nonetheless, on-campus renewables are being installed yearly, with goals of up to 20% of energy needs being sourced behind-the-meter by 2030 (Mon). This still leaves most of the energy to be sourced from state grids, thus the resulting influx of power purchase agreements by all universities (or controlling government, in the case of ANU) to be able to reach 100% renewable and carbon-neutral targets.

In terms of electrification targets, Mon and UQ stand out as having the most ambitious targets for electrification. UQ already has the lowest reliance on natural gas out of the Go8, largely thanks to having the warmest climate and no need for gas heating. UQ is also committing to a 25% electric vehicle fleet by 2025, including intercampus commuter buses. Mon has a much steeper trajectory towards total electrification due particularly to their higher reliance on gas heating, but have committed to eliminating all gas heating, water, and appliances by 2030.

### *3.5. Target for Absolute Emissions Reductions*

UNSW was the only university to explicitly include absolute reduction targets related to their total Scope 1–3 emissions. However, other universities have targets to reduce or cap aspects of consumption, which would have the same effect. UoM, Mon, and UWA all have substantial targets for reducing energy consumption, with UoM being the most ambitious at 18 to 25 GWh reduction per annum (equivalent to an 8% to 12% reduction in total energy consumption from a 2019 baseline). However, UoM's previous sustainability plan had the same target, to "reduce electricity demand by 18,350 megawatt hours per year by 2020", which was reported to have been "partially met", with installed efficiencies equivalent to 1841 MWh (just 10% of the original target). The 2020 sustainability report acknowledged this shortfall, explaining that "planning for net-zero emissions electricity in 2021 through renewable energy PPAs has taken precedence over electricity demand reduction projects".

While ANU's beyond-zero strategy is still in development, the single mention of GHG emissions in their Strategic Plan is to "reduce our carbon emissions intensity over the life of the Plan". However, referring to emissions intensity rather than total emissions allows ANU to continue to increase their total emissions so long as they build larger and marginally more efficiently. Arguably better, therefore, is UQ's energy consumption target to maintain consumption below a 2019 baseline, which from an emissions point of view will still likely lead to carbon reductions as emissions intensities continue to decrease.

Lastly, while UoS say they "aspire to decrease our electricity and gas usage", they do not go as far as adding measurable targets. However, they target emissions related to Scope 3 airline travel, including a goal to reduce the number of kilometres flown on university business by 20%. This is one of the few examples where a university explicitly outlines a reduction in human consumption of a good or service, over targets and strategies that can be achieved solely with improved efficiencies and sourcing.

## **4. Discussion**

### *4.1. Emissions Trajectory of Go8 Universities*

Energy consumption and $CO_2$e emissions of Australian Go8 universities are influenced by size (defined as staff and student numbers, as well as gross floor area), geographic climate, and energy-efficiency measures. The effect of university size on emissions follows results from the UK, where energy consumption increased with income and floor space [25], data from the US that found universities with larger floor space had greater $CO_2$e emissions [26], and data from Taiwan where university emissions correlated with area and population [27]. However, we also found exceptions to the rule, notably UQ, which has reduced its consumption while continuing to increase its population. The COVID-19 pandemic had a significant impact on the energy consumption and Scope 1 and 2 emissions of most universities, and reductions were greatest in universities that were impacted by lockdowns (UoM and Mon, followed by UoS and UNSW), whereas the other universities had a lower pandemic impact.

Energy use and $CO_2$e emissions were closely linked in Go8 universities (Figure 2), indicating that no university was highly decarbonised yet. The reason is that the bulk of energy consumed in all universities is related to fossil-fuel-produced electricity (Scope 2), while direct Scope 1 emissions are minimal. The greatest energy consumers and Scope 1 emitters are the universities in the coldest climates (ANU, Mon, and UoM) that likely use gas for hot water and gas heating. However, Scope 1 emissions in these universities are still small (around 15% of all Scope 1 and 2 emissions). The universities in the coldest climate are also the least efficient in terms of energy intensity or emission intensity per gross floor area (Figure 3). Again, these universities will have substantial energy consumption for space heating in the colder winters.

All universities but UQ had an increase in energy consumption from 2011 to 2019. This was accompanied by significant population growth in all universities but UWA, with most universities experiencing student and staff increases of over 25%. Thus, it is likely that this increase in student population led to an increase in energy consumption, something that has also been observed for UK universities between 2012 and 2018 [28]. Decarbonisation was not uniform among universities: only three universities had emissions reductions in the observation period (UQ, UoA, and Mon), whereas the universities with the greatest increase in energy consumption (UoS and UNSW) also had significant increases in $CO_2$e emissions (25% increase from 2011 to 2019). However, despite the increases in population and energy consumption, the emissions remained relatively stable, leading to a decrease in the per-capita emissions. It is not clear what caused this divergent response, e.g., if decarbonisation efforts such as on-site renewable energy generation, energy-efficiency measures, retrofitting of buildings, or densification actually differ among universities. However, UQ and Mon were the universities with larger deployments of on-site renewable energy, and all universities improved their per-person emissions intensity.

Differences in emissions among the universities are also attributed to the emissions intensity of the energy grid. The 2019 emissions intensities of purchased electricity differed considerably in Australia between states [15]. The state of Victoria had an emission factor of 1.07, NSW, ACT, and QLD of around 0.8, WA of 0.7, and SA of 0.5—the differences being a consequence of the amount of renewable energy in electricity production. This means that a university in Adelaide (South Australia, highest penetration of renewable energy) can use twice the electricity compared to a university in Melbourne (Victoria) and have the same emissions.

We can observe small steps in decarbonisation of energy, but Australian Go8 universities are far away from substantial emissions reductions. These results reflect 2015 findings from the UK that found 18 of 20 research-intensive universities had increasing emissions, despite having a prescribed sector target of a 34% reduction below 1990 by 2020 [29]. More recently, however, UK universities are achieving real emissions cuts, having reduced university sector-wide emissions by 30% between 2016 and 2022 [30], suggesting that while action lags behind rhetoric, the latter can bring about deep, rapid GHG reductions over the long term.

### 4.2. Reporting and GHG Emissions Disclosures

There is no common framework for universities to report Scope 1 to 3 emissions in Australia in a way that easily allows comparison across time and institutions. Earlier research has criticised a lack of standardisation across timescale (semester and year), emissions inclusion boundaries (what Scope 3 emissions to include/exclude), and functional unit (per student, employee, area, and economic expenditure) [6,31]. All these issues are observed in Australian universities.

There is a need to standardise how Scope 2 emissions are calculated and presented. Of the eight universities, only UNSW and UoM explicitly presented both market and location-based Scope 2 emissions within their sustainability reporting. Best practice, as stipulated by the GHG protocol, is to include location-based Scope 2 emissions even when market-based mechanisms are employed by the consumer [32]. Further, 100% renewable electricity claims made with the current "market method" are facing increasing "creative accounting" accusations [33]. This is because the current "annual matching" industry standard allows for energy consumption during periods of low/expensive renewables' generation (e.g., night-time and no wind) to be offset by periods of abundant/cheap generation (e.g., daytime and high wind) [32].

In response, “time-matched” or “24/7” renewable energy, where the day and hour of generation must match the day and hour of consumption, is emerging as an improvement on conventional annual matching [34]. As time-matching becomes a new standard, it will be crucial for universities to also disclose the temporal frame by which they are staking their “zero emissions” electricity claims.

Emissions disclosures under the NGER Act do not extend to Scope 3 emissions, causing vast discrepancies in included and excluded Scope 3 emission types among universities, and whether they are measured and disclosed at all. Even within UNSW’s comprehensive carbon inventory, student commuting is not considered a relevant Scope 3 emission. The primary reason for this is that GHG Protocol—a global standard for greenhouse gas emissions accounting and reporting—has no real guidance for universities. Instead, the closest equivalent category within their reporting framework for student commuting is Category 9: Downstream Transport and Distribution, from which corporations can opt to include “customers traveling to and from retail stores” [11]. However, universities in other countries are more comprehensive in their Scope 3 emissions reporting, e.g., Yale (US) and Cambridge (UK) have wider-ranging Scope 3 inventories, and the University of Salford (UK) and Stanford (US) even include travel of international students from and to their home countries in their Scope 3 emissions [35–38].

The lack of an accepted reporting framework is problematic: without clear guidance, universities can make claims of being “net-zero” or covering “all” emissions. Scope 3 emissions remain drastically under-reported [39] and neglected in carbon management policies [40]. Thus, it is imperative that there are globally accepted guidelines on inclusions and exclusions for Scope 3 emissions that must be followed and reported.

### *4.3. Net-Zero Strategies*

All Go8 universities have a net-zero target in the coming years. However, decarbonisation strategies—if they exist—have yet to have a significant impact on emissions, if emissions are calculated using a “location-based” methodology, as required by the NGER Act. Instead, net-zero is being achieved largely through “market-based” methodologies, which allows for emissions to be offset using carbon credits (ACCUs and VCUs) and Renewable Energy Certificates (RECs). Only three universities decreased their Scope 1 and 2 emissions between 2011 and 2019, and Scope 3 emissions have large uncertainties.

Universities with greater Scope 3 reduction goals still lack strategies as to what and how they will influence their value chains, but primarily target staff flights and waste disposal. In a country with a substantial mining and fossil fuel industry, it might be more prudent for universities to fully disclose and account for their investments. However, only UNSW accounted for the Scope 3 emissions associated with their investments. The Greenhouse Gas Protocol may be responsible for this under-reporting, as the guidelines for Scope 3 investment emissions indicate that mainly ‘investors and financial services’ companies should report these emissions.

Using market-based decarbonisation mechanisms can have negative consequences for energy consumption on campuses. It gives university administrators little incentive to focus on energy efficiency and/or energy demand flexibility. This is especially the case in ANU, where the ACT government has relieved the university of the costs associated with purchasing RECs. If electricity use is already ‘clean’, why reduce it? If ‘clean’ electricity can be purchased at a fixed price, why install solar generation on campus? Consequently, perhaps, ANU has the lowest installation of on-campus renewables, no renewable energy targets, and is the least energy-efficient university in the Go8.

Power purchase agreements featured in the sustainability strategies of seven out of the eight universities examined. There is no doubt that PPAs are a useful tool for many universities to bridge their emissions gap when providing 100% on-site renewable electricity is unfeasible. However, the relative ease at which “100% renewable electricity” claims can be made through PPAs has the unintended consequence of shifting focus away from energy-efficiency measures, on-site renewables (actions regarded as more desirable within a carbon management hierarchy), and energy storage. To better reflect the realities of PPAs, regulation should be enacted around accurate claims, and an emissions inventory should be created to consider lifecycle emissions related to renewables. To incentivise more efficient consumption and support a system-wide transition to renewables, the timescale of 'net-zero' electricity should also transition away from annual towards hourly, or every 5 min, to reflect the real spot pricing of the NEM.

Thus, while all Go8 universities have a net-zero target and most have a net-zero strategy, they focus on the tail-end of the carbon mitigation hierarchy. Instead of avoiding or eliminating emissions through replacement of fossil fuels or reducing emissions through greater energy-efficiency measures, the universities are focusing on offsetting existing emissions and market-based mechanisms, such as power purchase agreements. In addition, these mechanisms only address about 20% of the emissions in Scope 1 and 2, whereas the bulk of emissions in Scope 3 remain side-lined. A more comprehensive strategy that also considers mechanisms to measure and reduce indirect Scope 3 emissions is clearly needed.

### *4.4. Third-Party Accreditation and Legitimacy*

With five of the Go8 universities aiming to achieve net-zero emissions by 2025, a question arises about who—if anyone—will act as a watchdog to ensure the legitimacy of these claims.

The National Greenhouse and Energy Reporting scheme by the Clean Energy Regulator in Australia is central to the collection and provision of standardised, reliable emissions data. While many third-party overseers exist in the market, including Climate Active, STARS, RE100, and the Science-Based Targets initiative, they all rely on payment and voluntary submissions, and thus do not have the same leverage as that available to the Australian Government. Third parties, such as Climate Active, have also been criticised for being overly generous in granting net-zero accreditation, accepting "cradle-to-gate" rather than "cradle-to-grave" emissions boundaries and allowing companies to heavily rely on cheap international offsets rather than real emission reductions [41,42].

Considering that the position the NGER Act holds is unattainable to other third-party accreditors, improvements to the Act are imperative. Australia could look to the UK, where a more transparent, granular, and industry-specific reporting scheme is in place for all universities [43]. In terms of industry-wide changes, the EU and California are making headway: the Corporate Sustainability Reporting Directive and Climate Corporate Data Accountability Act will require large businesses to measure and report their Scope 3 emissions on a standardised platform from 2025 and 2027 onwards, respectively [44,45]. The Australian Government is currently considering a similar proposal to expand NGER disclosures [46]. While time will reveal the comprehensiveness of potential new legislation, improved corporate climate disclosures will hopefully be on Australia's horizon.

In collecting data, we discovered a lack of rigour in third-party accreditation. UoS under-reported their Scope 1 and 2 values by a factor of 1000 (Figure 4) within STARS. ANU under-reported their 2020–2021 energy consumption by 50% and their Scope 2 emissions by 85% to the Australian Government Clean Energy Regulator and, with emissions values below the publishing threshold, this was only discovered upon us requesting NGER data directly from the university. These are only cases where errors were caught because emissions data were blatantly incorrect: it is unknown how many more errors—accidental or deliberate—lie within the data. These case studies add to the call for a common, publicly available standard by which emissions can be tracked across time, fairly compared between institutions, and guide universities towards science-backed, trusted, and legitimate net-zero outcomes.

### *4.5. Limitations and Further Research*

Our study highlights some key limitations of GHG emissions reporting and data availability in Australia. The government's 50 kt $CO_2$e threshold for mandatory corporate emissions reporting means that emissions data for all but six Australian universities are not made publicly available. Key variables of universities, such as gross floor area or fully enclosed covered area, are difficult to obtain, or do not exist. Thus, a better reporting system of emissions and key organisational characteristics would lead to a more transparent reporting system for emissions.

Furthermore, obtaining more temporally granular population data would enable comparisons across institutions with varying in-person hours and provision of public amenities. Further research that utilises attendance records, remote sensing, or other spatial-tracking methods could allow a shift from today's standard of a "per person per year" metric to "per person per hour", ensuring that institutions are not disadvantaged for providing spaces and amenities that benefit a larger number of people over extended durations.

Lastly, expanding the study to all universities in Australia would offer a more comprehensive assessment across the whole higher-education sector and uncover trends with increased likelihood of statistical significance. Similarly, future research could expand on this analysis of net-zero actions related to university operations with an assessment of net-zero strategies around teaching, research, and public engagement.

## 5. Conclusions

Universities play a central role in educating future workforces, developing cutting-edge climate technologies, and enacting emissions reductions in their operations. Our research highlights that Australian Go8 universities are not at the forefront of actual climate mitigation. Over the last decade, their direct emissions have plateaued, and their sustainability reporting lacks transparency and accuracy. Most universities have no realistic plan to decrease energy demand, have no targets to minimise direct emissions, and aim to achieve net-zero through carbon offsets and renewable electricity credits. Very few universities have actual climate targets in their net-zero plans that would force university operations to change their business-as-usual approaches. In the carbon management hierarchy of: (1) avoid emissions → (2) reduce emissions (through efficiencies and substitution) → (3) install on-site renewable energy → (4) purchase off-site renewable energy → (5) offset remaining emissions, Australian universities only act seriously on the last two. Our research highlights the need for greater transparency and oversight over Australian universities' claims and plans over decarbonisation and net-zero.

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