Developing a Practical Framework of Sustainability Indicators Relevant to All Higher Education Institutions to Enable Meaningful International Rankings

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Abstract: Higher Education Institutions (HEIs) sustainability assessments are receiving significant attention in the academic literature, with ever more complex grading and ranking systems being developed. This paper aims to provide national policy makers with a simple set of indicators to facilitate measuring progress towards sustainability for the HEI sector, within the context of national sustainability data collection efforts. Candidate indicators were identified and assessed from the two most subscribed to HEI sustainability assessments, namely, the UIGreenMetric and STARS, to develop a sector specific indicator set. This resulted in a final set of 12 indicators, covering on-site energy, greenhouse gas emissions, solid waste, water, travel, education, research, and governance. The proposed indicator set was then compared to publicly available data for Irish HEIs, to identify gaps in data collection, which found that direct campus energy use and associated Scope 1 and 2 emission data alone were collected with sufficient rigour. The described indicator set has the potential to be applied to guiding national sustainability transitions globally and offers a template for accelerating sustainability data collection efforts for the HEI sector.

Keywords: sustainability indicators; higher education institutions; sustainability transitions; campus sustainability

1. Introduction

Higher Educational Institutions (HEIs) have been identified as actors with considerable influence in shaping the mindsets and values of the general population in relation to sustainability issues through education, while also playing a significant role in societal transitions toward sustainable development patterns through research and collaboration with societal actors [1–8]. As educators of future generations and the leaders of tomorrow, HEIs have a duty to act more sustainably themselves, and more importantly to act as leverage points in the broader societal transition towards sustainability [9–11]. It is increasingly recognised that these institutions charged with academic research, innovative development, and education are contributing significantly to environmental damage and failing in their duty of care toward the environment [12,13]. Numerous ways in which HEIs can facilitate transitions towards sustainability include changes in education curriculum, governance structures, campus operations, research focus, and outreach activities, as current practices are considered by many authors to be unsustainable in the long term [14–18].

While the environmental impacts relating to higher education are relatively small when compared to other sectors [19,20], HEI campuses have been identified as ideal testing grounds (often called livings labs) to experiment and demonstrate sustainability solutions on campus in a "real world" setting that could subsequently be upscaled to wider society [21–24]. This perspective may be adopted, as HEI campuses represent microcosms of society, or alternatively may be regarded as small cities due to their size, diverse population, and responsibility for numerous complex activities and operations,

and the associated direct and indirect environmental impacts [25–27]. HEIs are well placed to assume a central role in the co-design and co-production of knowledge and tools for societal transformations towards sustainability, in partnership with diverse external stakeholders from industry, government, and civil society [28]. HEIs are often expected to play a significant supporting role to engage willing actors in sustainability transitions at regional scale [29].

Campuses also have control of space, infrastructure, and resources to fulfil their functions and more importantly adding additional functions [14,30]. Given that HEI campuses create negative environmental impacts, the logical step for campuses, to facilitate society's transition towards sustainability, is to reduce their material and energy demands [31]. Individual organisations such as HEIs cannot independently be fully sustainable, as they rely on services outside their control, but can play a role in creating systems at societal level that stay within planetary boundaries (20). Therefore, it is vital that HEIs go beyond limiting their own environmental impacts and act as change agents in facilitating wider society's transition towards sustainability (3). HEI also have the potential to create a workforce for sustainable industries within the economy [16,32]. By facilitating growth within these industries through collaboration and demonstration of products and services on campus, the HEI sector may increase the attractiveness of green careers among current and prospective students, as well as normalising the use of sustainability solutions [33].

Monitoring and assessment have become a focus of HEI sustainability research internationally [34]. In relation to HEI sustainability indicator frameworks, there exists a plethora of indicators, indicator sets, and assessment frameworks described in the international literature [15,25,35–38]. The main objectives of sustainability assessment and reporting at HEIs are (1) assessing HEI organisational sustainability; (2) communicating with its stakeholders; (3) benchmarking against other organizations; (4) analysing how the organization affects and is affected by stakeholders; (5) assessing and improving sustainability performance over time; and (6) planning the future direction of change towards sustainability in HEIs [39]. Sustainability assessments have developed as tools for identifying best practice, communicating goals and experiences, and measuring progress towards the goal of achieving a sustainable campus [40]. In practice however, sustainability assessment and reporting by HEIs is currently in a developmental stage [27,41].

2. Materials and Methods

The objective of this paper is to assess the current extent of sustainability indicator utilisation and to outline a practical process for development of sustainability indicator sets for the HEI sector, with illustrative application to Ireland's higher education sector. A critical assessment of selected existing international indicator frameworks was undertaken to identify the most frequently adopted sustainability indicator frameworks in use. Drawing on the findings of this review, an indicator set for the HEI sector is described based on indicator similarities identified between the UIGreenMetric and STARS. The proposed indicator set is then assessed against data availability by comparison with current data collection methods adopted by HEIs in Ireland.

2.1. Indicator Frameworks at HEIs

Indicators have been adopted in monitoring performance of HEIs, including tracking enrolment numbers over time, grading of student examinations and monitoring contributions to social cohesion and national economies. Indicators have been used to guide decision making by aggregating complex realities to provide accessible information that is useful in communicating with the general public and stakeholders [42]. On the other hand, it is seen as important not to condense the complexity associated with measuring societal development down to a single aggregate indicator, for example, gross domestic product (GDP) [42–45], as the multifaceted nature of societal development cannot be captured with such a narrow perspective. To combat such oversimplification, a more appropriate approach has been suggested, whereby the development of sustainability indicator sets

and indices that reflect the multiple dimensions associated with sustainability transitions be adopted [30]. However, gathering data for many indicators will take up substantial amounts of time and effort for many institutions, as was seen by countries monitoring implementation of the United Nations Sustainable Development Goals [46]. To strike the appropriate balance between limiting oversimplification and controlling burdensome complexity, a certain amount of subjectivity may be inevitable, arising from the goals of those undertaking this task [47].

The most widely recognised indicator frameworks within the HEI sector include the Times Higher Education (THE) University Rankings [48], the Quacquarelli Symonds (QS) World University Rankings [49] and the Shanghai Academic Ranking of World Universities [50]. As shown in Table 1, these frameworks focus on criteria such as teaching quality, research output, and industry related income. According to [51], "indicators arise from values (we measure what we care about), and they create value (we care about what we measure)". Thus, as an example, world university rankings, such as THE, QS, and ARWU, are regarded by some authors as a manifestation of corporatisation of higher education, in which market forces increasingly govern research and teaching, thus leading to the marketisation of education, and the commodification of knowledge [52–54]. By including indicators such as the number of international staff and students in determining a HEI ranking, the framework assumes that HEIs' contribution to the process of globalisation is an important role to play [55,56]. The same could be said of indicators relating to HEIs being important actors in economic development, where they relate to industry and research incomes, and employer reputation [57,58]. The effectiveness of these ranking frameworks in the promotion of their agenda is evidenced where many universities, particularly in Europe and Asia Pacific, adjust their strategic plans to become "world-class" universities as defined by their rankings [53].

Table 1. International HEI indicator frameworks and associated indicators.

Framework	Criteria	Indicator	Weighting
Times Higher Education University Ranking (THE)	Teaching	Reputation survey	15%
		Student to staff ratio	4.5%
		Doctorate to Bachelors rating	2.25%
		Doctorates awarded to academic staff ratio	6%
		Institutional income	2.25%
	Research	Reputation survey	18%
		Research income	6%
		Research productivity	6%
	Citations	Citations	30%
	International outlook	International to domestic student ratio	2.5%
		International to domestic staff ratio	2.5%
		International collaboration	2.5%
	Industry income	Industry income	2.5%

Table 1. *Cont.*

Framework	Criteria	Indicator	Weighting
Academic Ranking of World Universities (ARWU)	Quality of education	Alumni of an institution winning Nobel Prizes and Field Medals	10%
		Staff of an institution winning a Nobel Prize	20%
	Quality of faculty	Highly cited researchers in 21 broad subject categories	20%
		Papers published in Nature and Science	20%
	Research output	Papers indexed in Science Citation Index-expanded and Social Science Citation	20%
	Per capita performance	Per capita academic performance of an institution	10%
Quacquarelli Symonds World University Rankings (QS)	Academic reputation	Academic survey	40%
	Employer reputation	Employer survey	10%
	Faculty to student ratio	Faculty to student ratio	20%
	Citation per faculty	Total number of citations received by institution produced papers over a five-year period divided by faculty members	20%
	International faculty ratio	Proportion of international faculty compared to total	5%
	International student ratio	Proportion of international student compared to total	5%

Note that none of these ranking systems include indicators that estimate campus environmental performance or contributions to national sustainability transitions (beyond citations in high impact factor journals or Nobel prize winners in environmental fields), which emphasizes that these matters are not a priority to those creating the assessments, which in turn does not incentivise those hoping to perform well in these indicator frameworks to focus on campus sustainability issues. In reaction to increasing concern over sustainability at international policy level, and HEIs becoming increasing concerned with corporate social responsibility, the mainstream HEI assessment frameworks have also developed tools, for example, THE developed the University Impact Ranking, which aims to link HEI actions to the 17 United Nations Sustainable Development Goals in four broad functions, namely research, outreach, stewardship, and teaching [59]. It is suggested that "being green" is increasingly impacting global university rankings, and that enhancing environmental sustainability can serve as a competitive advantage [60].

The THE Impact Rankings map HEI to the 17 United Nations Sustainable Development Goals (SDG), with SDG 17 the only mandatory reporting requirement, and individual HEIs given liberty to focus on three further SDGs for inclusion in calculation of their ranking score. An HEI final score is calculated by combining its score in SDG 17 with its top three scores out of the remaining 16 SDGs. SDG 17 accounts for 22% of the overall score, while the other SDGs each carry a weighting of 26%. In this way, HEIs are scored based on differing sets of SDGs. As HEIs are not expected to report on all of the SDGs, there is significant replication of indicator usage and potential double counting between the SDGs. For example, the proportion of first-generation students is an indicator for both SDG 4 (Quality Education) and SDG 10: (Reduced Inequality). Similar double counting is also possible with indictors relating to citations for clean energy in SDG 7 (Affordable and Clean Energy) potentially having significant overlaps with climate action citations for SDG 13 (Climate Action). Due to the lack of a standardised approach for comparison between HEIs,

and significant potential for double counting between SDGs, the THE Impact Ranking framework was not explored further in this study, because here it is assumed that for transparent and meaningful comparison of HEIs, nationally and internationally, a common approach to HEI assessments must be adopted.

2.2. Sustainability Indicators at HEIs

Due to the impact HEI indicator frameworks such as THE, QS, and ARWU have had in shaping strategies and agendas internationally, several similarly styled ranking frameworks have been developed by researchers to rank HEI performance in transforming their institutions in the direction of sustainability, and also their contributing to wider social transitions towards sustainability [11]. This has led to a proliferation of indicators framework proposals in the academic literature, with an indicative list provided in Table 2. These sustainability indicator frameworks for HEIs are referred to in the literature as 'Sustainability Assessment Tools' and 'Campus Sustainability Assessments'.

Table 2. Indicative list of HEI sustainability assessment frameworks.

Sustainability Indicator Frameworks	Source
Graphical Assessment of Sustainability in Universities	[2]
National Wildlife Federation's State of the Campus Environment	[35]
Sustainability Assessment Questionnaire	[35]
Auditing Instrument for Sustainability in Higher Education (AISHE)	[35]
Higher Educations 21st Sustainability Indicators	[35]
Environmental Workbook and Report	[35]
Greening Campus	[35]
Campus Ecology	[35]
Environmental Performance Survey	[35]
Indicators Snapshot/Guide	[35]
EMS self-assessment	[35]
Sustainability Assessment for Higher Technological Education (SAHTE)	[61]
Untitled approach based on Quantitative Scoring Method (QSM) and Analytical Hierarchal Processes (AHP)	[62]
People and Planet League	[63]
Composite Indicators for a Sustainable Campus	[64]
Three-dimensional University Ranking (TUR)	[65]
DPSEEA-Sustainability index Model (D-SiM)	[66]
The Sustainable Tracking, Assessment and Rating System (STARS)	[38]
The Sustainable Endowment Institutes College Sustainability Report Card	[38]
Sierra Club's Cool Schools	[38]
The American College and University Presidents Climate Commitment (ACUPCC)	[38]
The Guardians Green League	[38]
Princeton Review's Green Ratings	[38]
The Pacific Sustainability Index	[38]
The University of Indonesia's GreenMetric	[38]

Here the focus is on the most frequently adopted frameworks works at international scale, namely the Sustainable Tracking, Assessment, and Rating System (STARS), and the UI GreenMetric. As of 2020, STARS had 1016 participant HEIs registered to use the reporting tool, with 671 receiving a STARS rating, in 42 countries [67]. The UI Green Metric,

established in 2010, had participation from 95 HEI in 35 countries. By 2019, 778 HEIs in 75 countries were ranked [68].

As the UI Green Metric and STARS are the most subscribed to HEI sustainability assessments, a detailed analysis of indicator utilisation was carried out on each to assess their value as a guide for the HEI sectors transition towards sustainability. Table 3 shows the main criteria utilised by both the UI Green Metric and STARS and their associated weightings. It is clear from Table 3 that the UI Green Metric is primarily focused on the operational aspects of campus sustainability, accounting for 82% of the frameworks weighting, while the STARS framework assigns the operational aspect 35% of its total weighting. Education and Research account for the remainder of UI Green Metric at 18%, while STARS assesses a greater range of aspects of campus sustainability with academics, engagement, planning, and administration focused criteria receiving weightings of 29%, 20%, and 16%, respectively. Additional bonus points are available in the STARS assessment relating to innovation and administration. These can account for up to 2% of total weightings. It is worth noting that certain sub-criteria (discussed later) within the STARS framework do not apply to all HEIs, and their associated points are subsequently not included in final scoring.

Table 3. Weighting of criteria for UI Green Metric and STARS.

Framework	Criteria	Weighting
UI Green Metric [69]	Setting and Infrastructure	15%
	Energy and climate change	21%
	Waste	18%
	Water	10%
	Transportation	18%
	Education and Research	18%
The Sustainable Tracking, Assessment, and Rating System [68]	Academics	29%
	Engagement	20%
	Operations	35%
	Planning and Administration	16%
	Innovation and Leadership	Bonus of 2%

2.2.1. Universitas Indonesia Green Metric

Each of the categories utilised by the UI Green Metric and their associated indicators and units were analysed to identify the benefits and challenges associated with adoption of such indicators to inform sectoral analysis. The indicators included in the framework have evolved over time, with 23 indicators in the initial framework in 2010, and 39 indicators in 2019. According to guideline documentation for the UI Green Metric, the framework was developed for several reasons, namely, to facilitate recognition of sustainability initiatives at HEIs on a global scale, increase the awareness of sustainability issues, encourage social change and action, and facilitate networking among participating HEIs. Adopting the framework entails collecting data relating to defined indicators, which are then scored according to a weighted scale using the associated points for each level of the scale, with each indicator in turn weighted within the entire framework. For example, the indicator relating to the ratio of open space area to total campus area is scored out of 300 points (100 points in the scoring system accounts for 1% of total weighting in the 2018 rankings). If the ratio of open space to total campus area was found to be less than 1%, a score of zero is assigned (0 points), whereas if the ratio was between 1–70%, a quarter of the maximum points (75 points) is assigned, for ratios between 70–85%, half points (150 points) are awarded, ratios grater then 85–92% receive three quarters of total points (225 points), and a full score is assigned to HEIs with a ratio of greater than 92% (300 points). A similar scoring mechanism is employed for all indicators within the UI Green Metric framework.

From analysing the indicators of the UI GreenMetric, it is evident that environmental intensity metrics dominate, with no indicators relating to the absolute improvement in campus sustainability. These intensity indicators are primarily concerned with incremental change in that the units are per capita, per unit area, and relative improvements measured as percentage improvement on a baseline. A problem associated with relying on efficiency measures alone in measuring HEI environmental performance is that they may give a false estimation of progress over time. This is seen with per capita indicators, where the intensity of resource use or environmental impact may decrease due to an increase in student or staff numbers, and not because of successful implementation of campus greening, that is measures to reduce the environmental impacts associated with HEI material and energy throughput. With per unit area indicators, intensity of impacts may be observed to fall due to an increase in new building stock, while the absolute resource use and negative impacts of the campus remained unchanged or increased. To achieve a more comprehensive assessment of HEI systems change, absolute indicators of campus improvement (e.g., tCO2e progress towards zero) are needed to complement efficiency indicators. The fact that absolute figures relating to operational aspects of HEI are collected as a prerequisite to calculation of efficiency metrics means that no extra effort is required in data collection.

UI GreenMetric also utilises indicators that are criteria based, in that points are allocated for meeting predefined criteria. An example is the indicator relating to sewage disposal. This gauges the primary method of sewage treatment at a campus with zero points for disposing of sewage untreated into waterways, 25% of points for conventional treatment, 50% of points for being treated technically, 75% for treatment for downcycling and full points for treatment for upcycling. One controversial indicator utilised by the UI GreenMetric relates to renewable energy sources on campus, where combined heat and power technology is considered a renewable energy source even if fossil fuels are utilised.

While the UI GreenMetric framework is potentially applicable to all HEIs, the utilisation of indicators that reward campuses for having large open spaces, campus forest cover, and vegetation cover as a percentage of total area limits its adoption, particularly among HEIs in urban areas, which are likely to score poorly for these metrics. To overcome this limitation, a fairer framework might tailor indicators adopted, based on HEI location.

The UI GreenMetric also utilises education and research indicators to capture HEI characteristics, such as the ratio of sustainability focused courses to total courses, the ratio of research spending on sustainability to total research funding and sustainability related publications annually. While measurement of these indicators may be useful in highlighting the characteristic of HEIs in terms of their curriculum and research sustainability coverage, individual HEIs have very limited scope to change these characteristics year on year. In scoring, such indicators might be expected to reward smaller and sustainability focused institutions, while penalising larger HEIs that are more strongly multidisciplinary in teaching and research.

Also included in the education and research category is governance or management indicators for HEI sustainability, such as publishing a sustainability reports and operating a sustainability website. The inclusion of such indicators may be useful in promoting sustainability awareness at HEIs as they prescribe actions that all HEIs may actively pursue.

2.2.2. The Sustainable Tracking, Assessment, and Rating System (STARS)

The STARS indicator framework contains 64 indicators, which in turn comprise a further 90 sub-indicators. HEIs gain credits for their performance on each indicator, with certain indicators not applicable to all HEIs. For this reason, the STARS framework allocates four rankings for HEI, based on their performance relative to the maximum total credits applicable to the HEI in question. These rankings include Bronze (minimum of 25% of credits), Silver (minimum of 45% of credits), Gold (minimum of 65% of credits), and Platinum (minimum of 85% of credits).

The indicators utilised to allocate credits for improvements in operational sustainability are all environmental efficiency metrics, with no absolute indicators utilised in the

allocation of credits, similar to the UI GreenMetric. Unlike the UI Green Metric, STARS tailors indicators based on their HEI context. For example, more credits are available for improvement in water quality in water scarce countries than in water abundant countries. Such a mechanism is designed to support a fairer approach in allocation of points for HEIs based on local circumstances.

While the STARS framework captures many data relating to sustainability at HEIs, there is the potential for double counting of efforts taken by HEIs in transitioning towards sustainability. Gross internal area of HEI is strongly correlated with energy use and GHG emissions [7,40,69,70]. Therefore, separate indicators measuring progress in reducing Scope 1 and 2 emissions, building energy usage, and building certified space based on energy efficiency, may be considered double counting, as each indicator is measuring progress towards energy efficiency of the campus built environment.

The STARS Technical Manual [71] states that nuclear energy and resultant pollutants are damaging to the environment. It also states that large scale hydropower infrastructure may also be damaging to the environment. This suggests that the views taken by those who selected the indicators influenced their choices, as they deem nuclear power and large scale hydropower as environmentally damaging sources of energy, which is contested by some authors [72,73]. This in turn encourages adoption of these assumptions among HEIs that utilise this assessment tool.

The STARS framework has curriculum and research indicators such as the ratio of sustainability focused courses to total courses, and the ratio of research spending on sustainability in relation to total research funding, both measured in percentage terms. The framework also utilises sustainability governance and management indictors such as the employment of a sustainability officer, energy manager, or equivalent and the implementation of sustainability policies, practices, and environmental management systems.

3. Results and Discussion

Drawing on the critical review of sustainability indicator usage among both HEI sustainability assessments, a practical indicator set was developed for the HEI sector. The process of indictor selection for the HEI sector involved collating indicators utilised in both UIGreenMetric and STARS, and identifying similarities in indicator utilisation to develop a final indicator set. The indicators that satisfied this screening process are shown in Table 4. A total of 12 indicators were identified, covering energy, greenhouse gas emissions, waste, water, and transport for campuses, with additional indicators identified relating to sustainability education and research, as well as management and governance indicators. To monitor successful implementation of campus greening actions over time, particularly relating to operational indicators, it is suggested that both absolute and relative units (Table 4) are reported. This is to avoid a false estimation of progress often presented by utilising exclusively intensity metrics, which may misrepresent resource intensity improvements as due to campus greening, rather than being attributed to an increase in campus physical size or population. To achieve a more comprehensive assessment of HEI systems change, absolute indicators of campus improvement are needed to complement efficiency indicators.

The proposed indicator set was then compared to publicly available data for Irish HEIs, to identify gaps in data collection by public bodies and agencies in Ireland, including the Sustainable Energy Authority of Ireland [74], the Environmental Protection Agency [75,76], the National Transport Authority [77], and the Higher Education Authority [78]. Of the 12 indicators that qualified according to the selection criteria described above, data for only two indicators, namely, campus energy use, and Scope 1 and 2 GHG emissions, were currently being collected for the HEI sector and made publicly available. There was partial data availability (only available for some HEIs) relating to two indicators, namely commuting and environmental sustainability policies. Data for the remaining eight indicators selected are either not being collected or not publicly available.

From this analysis, it is evident that data gaps relate to the collection of data surrounding operation indicators at Irish HEIs, with energy consumption the only area that is adequately addressed. Significant gaps in data were identified relating to water consumption, wastewater generation, solid waste generation, and the associated GHG emissions for each of these flows at Irish HEIs.

Table 4. Simplified Sustainability Indicator Framework for HEI sector, and responsible Irish Data Collection Agencies.

Dimension	Indicator	Collection Body at HEI Sector Level	Publicly Available	Units, Absolute (A) or Relative (R)
Energy	Energy Consumption	SEAI	Yes	Grid electricity (kWh), On-site renewable electricity (kWh), On-site fossil fuels (kWh), On-site thermal renewables (kWh) **(A)**
				Energy source per unit area (kWh/m^2) Building certified space (% of total building area) **(R)**
				Energy source per student and staff (kWh/Fulltime Equivalent) **(R)**
GHG Emissions	GHG (Scope 1 and 2)	SEAI	Yes	Grid electricity (CO_{2e}), on-site fossil fuels (CO_{2e}) **(A)**
				Scope 1 and 2 source per unit area (CO_{2e}/m^2) **(R)**
				Scope 1 and 2 per student and staff (CO_{2e}/FTE) **(R)**
	GHG (Scope 3)	None	No	Student and staff commuting (CO_{2e}), waste (CO_{2e}), water supply (CO_{2e}), waste water (CO_{2e}), supply chain (CO_{2e}), **(A)**
				Scope 3 source per unit area (CO_{2e}/m^2) **(R)**
				Scope 3 per student and staff (CO_{2e}/FTE) **(R)**
	Carbon Sequestration or Forest/Vegetation Cover	None	No	Forest cover (CO_{2e} absorbed), Vegetation cover (CO_{2e} absorbed), Green roofs (CO_{2e} absorbed), **(A)**
				Carbon sink per unit area (CO_{2e} absorbed/m^2) **(R)**
				Carbon sink per student and staff (CO_{2e} absorbed/FTE) **(R)**

Table 4. *Cont.*

Dimension	Indicator	Collection Body at HEI Sector Level	Publicly Available	Units, Absolute (A) or Relative (R)
Waste	Waste Generation	None	No	General waste (kg, m^3), dry mixed recyclables (kg, m^3),compost (kg, m^3) **(A)**
				Waste type per unit area (kg/m^2, m^3/m^2) **(R)**
				Waste type per student and staff (kg/FTE, m^3/FTE) **(R)**
Water	Water Consumption	None	No	Water supply (m^3), Rainwater harvested (m^3) **(A)**
				Water source per unit area (m^3/m^2) **(R)**
				Water Source per student and staff (m^3/FTE) **(R)**
	Waste Water Production	None	No	Waste Water (m^3) **(A)**
				Waste Water per unit area (m^3/m^2) **(R)**
				Waste Water per student and staff (m^3/FTE) **(R)**
Transport	Commuting	National Transport Authority	Partial	Internal combustion engine car (km), electric car (km), bus (km), train (km), tram (km), cycling (km), walking (km). **(A)**
				Modal split of travel (%) **(R)**
Education and Research	Sustainability Education	None	No	Number of courses, modules **(A)**
				Ratio of Sustainability Focused Courses to Total Courses (%) **(R)**
	Sustainability Research	None	No	Number of publications, living lab projects, research funding **(A)**
				Ratio of Research Spending on Sustainability to Total Research Funding (%) **(R)**

Table 4. *Cont.*

Dimension	Indicator	Collection Body at HEI Sector Level	Publicly Available	Units, Absolute (A) or Relative (R)
Management and Governance	Employed Sustainability Staff	None	None	Number of sustainability staff **(A)**
				Sustainability staff per student and staff **(R)**
	Sustainability Policy	HEA Compacts	Partial	Number of policies for energy, waste, waste, transport, GHG emissions, education **(A)**

To limit the complexity associated with assessing the HEI sectors transition towards sustainability, the indicator framework in Table 4 offers a useful tool to inform national policy makers. However, as with any simplification of complex systems, it has a number of limitations. A limited number of HEI sustainability assessments were reviewed, and the very large range of candidate indicators identified through literature review were not all evaluated. It is to be expected that the indicator framework will be altered in future in light of experience in collecting data, and changes to national and HEI policy. It should also be noted that in choosing solely the most popular HEI assessment frameworks to inform indicator selection, the proposed indicator set relies on popular consensus, rather than the expert opinion of individuals, which tends to inform a majority of relevant academic literature. This method was selected as being more likely to encourage widespread adoption of the proposed indictors, as a significant number of HEIs have already shown that they are able to collect data for these indicators.

As mentioned in the assessment of UIGreenMetric and STARS, indicators relating to vegetation cover disproportionately favoured HEIs with large estates and penalised those in settlement centres. Additionally, there was found to be an overemphasis on efficiency indicators within both assessments, without focusing on absolute improvements in resource utilisation and reduction of pollution, which are essential to meeting international goals, for example, in greenhouse gas emission reduction. However, both of these types of indicators have been included in the final HEI sustainability indicator set, as they are useful in guiding national sectorial baselining, and more importantly, are not scored or ranked, which avoids penalising or rewarding HEIs based on their local characteristics, and the likelihood of double counting of progress towards sustainability. The absence of ranking in the proposed framework makes it relevant to all HEIs, as it does not penalise HEIs based on their local attributes as most HEI sustainability frameworks do. However, despite the general pitfalls associated with scoring and ranking, which are equally applicable to HEI sustainability indexes, the widespread adoption of frameworks that use such mechanisms to gauge progress relative to other HEIs can often be a motivating factor to promote campus greening activities. To facilitate scoring and ranking of campuses utilising the proposed indicator set, each of the dimensions identified in Table 4 could be equally weighted to promote each dimension receiving equal attention. These dimension weightings have the potential to be adjusted accordingly to suit HEI and national sector priorities.

Indicators relating to biodiversity were not included in Table 4, reflecting the difficulty in framing indicators and metrics that accurately assess biodiversity. The likely impact of differing HEI locations has been mentioned, and in addition species richness and abundance may vary significantly year to year as a result of ecological and environmental processes over which the HEIs have no control. Further research is needed to find reliable indicators.

A useful example of good practice in data reporting is implemented in the United Kingdom. British HEIs are required to report their campus management data to the Higher Education Statistics Agency [79]. Reporting is required to secure continuing government

funding, and includes indicators relating to carbon emissions, energy consumption and generation, energy performance certificates, waste generation, water consumption and wastewater production, and transport mode used by staff and students. HESA indicators capture much of the environmental data required in relevant national data frameworks. A total of 24 indicators are utilised to collect data, which are composed of a further 216 sub-indicators. Indicators captured by the HESA with direct relevance to national sustainability indicators in Ireland including energy consumption of buildings; gross internal area display energy certificate ratings; GHG emissions for Scope 1, 2, and 3; waste by source; and volume of water supply and wastewater. However, no indicators relate to education, research, governance, and management, as defined in Table 4.

4. Conclusions

Existing international frameworks measure different aspects of sustainability and are not using optimal metrics, so for these reasons are not satisfactory for all HEIs to adopt for monitoring their transition to greater sustainability. The analysis of UIGreenMetric and STARS metrics revealed weaknesses in the indicators selected and metrics adopted, opening up the likelihood of double counting due to ranking and scoring of indicators. The novelty of this study entailed the development of a simple indicator set to guide the HEI sector on its transition towards sustainability, based on consensus between the most frequently used indicator frameworks, so that many HEIs will be familiar with indicators selected. International adoption of this framework may be expected to support more objective evaluation of the performance of HEIs and result in more transparent national and international comparisons of HEI performance in supporting national and international actions in transitioning to a more sustainable future. Significant data gaps were found in relation to some indicators, and there was a poor match between data gathered by HEIs and those needed to monitor progress on meeting Irish government targets on enhancing sustainability.

An objective of this analysis was to show how few Irish data were both captured and made public, and to offer a template for future data collection systems. If Irish HEIs were to adopt the proposed framework, it might be expected that government agencies might move to facilitate collection and publication of the necessary data to support a comprehensive assessment of progress for the sector nationally. By capturing data offering insights of progress being made in helping to meet national targets, HEIs might contribute more successfully to meeting national targets. Measuring sustainability at a moment in time provides limited information; more important is the rate at which campuses are improving their sustainability over time. In scoring, indicator weightings might reward campus showing ambitious continual improvement. Finally, the framework suggested may offer lessons for data collection in other sectors, particularly the wider public sector.

Author Contributions: W.H.: conceptualization, methodology, writing—original draft. B.O.: supervision, funding acquisition, methodology, writing—review and editing. All authors have read and agreed to the published version of the manuscript.

Institutional Review Board Statement: Not applicable.

Informed Consent Statement: Not applicable.

Data Availability Statement: Data sharing not applicable. No new data were created or analyzed in this study. Data sharing is not applicable to this article.

Conflicts of Interest: The authors declare no conflict of interest.

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