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Sustainable Higher Education Systems

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Synonyms

Greening higher education

Keywords

Sustainable higher education; Greening higher education; Sustainable Development Goals (SDGs); Education for Sustainable Development; Greening campus buildings; Designing sustainable teaching and learning systems.

Abstract:

Higher Education (HE) systems comprise institutions whose function is to support, develop and deliver teaching and learning at post-secondary or tertiary level. Many HE institutions also address research and/or provide enterprise services in partnership with other organisations in the private, public and third sectors. HE systems have therefore a key role in the development of citizens, society and the economy, including the knowledge, skills and behaviours needed to support sustainable development. A sustainable Higher education (HE) system may be defined in terms of the network of local, national and international HE institutions and their systems that sustain the core functions of HE, including the delivery of teaching and learning, research, and outreach, by addressing social, economic, and environmental targets and constraints influencing the HE institutional context. A sustainable HE system not only sustains the functions of HE institutions but supports the aims of sustainable development by advancing citizens' knowledge and skills to meet the needs of society and the economy and by promoting stewardship of the natural and built environment. This article examines the concept of sustainable HE systems and three key approaches to promote environmental sustainability and the Sustainable Development Goals (SDGs) established by the United Nations in 2015. These approaches include: greening the curriculum to encompass Education for Sustainable Development (ESD); greening campus buildings and site operations; and designing HE teaching and learning delivery systems, such as distance and online education systems, to minimise negative environmental impacts and carbon dioxide emissions.

Definition

A sustainable Higher education (HE) system may be defined in terms of the network of local, national and international HE institutions and their systems that sustain the core functions of HE, including the delivery of teaching and learning, research, and outreach, by addressing social, economic, and environmental targets and constraints influencing the HE institutional context. A sustainable HE system not only sustains the functions of HE institutions but supports the aims of sustainable development by advancing citizens' knowledge and skills to meet the needs of society and the economy and by promoting stewardship of the natural and built environment.

Introduction

Higher education (HE) systems comprise institutions whose function is to support, develop and deliver teaching and learning at post-secondary or tertiary level. Much of this teaching and learning is delivered at universities, although is also provided through colleges and polytechnics, and specialist course providers, including business schools, agricultural colleges and conservatoires. HE systems have a key role in the development of citizens, society, and culture, including changing current attitudes and practices toward sustainable development (Alonso-Almeida et al. 2015), as well as helping to support the economy through the provision of an educated workforce (Williams et al. 2013). While there are many sub-systems within the HE system providing, for example, a range of facilities for staff and students from accommodation to laboratory and sports facilities, the main HE system is focused on the provision of HE teaching and learning. This provision can be full-time or part-time and via campus-based face-to-face teaching, distance learning, or blended learning systems. Many HE institutions also conduct research and/or provide enterprise services in partnership with other organizations in the private, public, and third sectors, thereby supporting a view of HE as a system with permeable and fluid boundaries, which contributes to society through the creation and transfer of new knowledge, including knowledge of sustainable development (Gough and Scott 2007).

A sustainable HE system is arguably one in which the whole set of institutions involved with HE functions, including government and other support agencies, as well as higher education providers, work together to meet the sustainability triple bottom line of social equity, economic prosperity and environmental protection (Elkington 1999). Most of the literature, however, defines sustainable HE at the campus or university level. Hence a sustainable campus community is defined by Cole (2003) as *“one that acts upon its local and global responsibilities to protect and enhance the health and well-being of humans and ecosystems. It actively engages the knowledge of the university community to address the ecological and social challenges that we face now and in the future”*. Similarly Velazquez et al. (2006) defines the sustainable university as *“A higher educational institution, as a whole or as a part, that addresses, involves and promotes, on a regional or a global level, the minimization of negative environmental, economic, societal, and health effects generated in the use of their resources in order to fulfil its functions of teaching, research, outreach and partnership, and stewardship in ways to help society make the transition to sustainable lifestyles”*. Such definitions emphasize the local and global responsibilities of HE systems to minimize negative social, economic and environmental impacts, protect the ecosystem, and support the transition to sustainable lifestyles.

The HE sector has been concerned with its role in sustainable development over some decades (Gough and Scott 2007). However, Owens (2017) observes that HE has only recently been introduced explicitly into the Sustainable Development Goals (SDGs), following the United Nations (UN) General Assembly, which established a UN commitment to the 2030 Agenda for Global Sustainable Development (UN 2015). At this time, the UN replaced the Millennium Development Goals, which had focused on primary and secondary education in developing countries, with 17 SDGs of which some included targets and actions applicable to HE. The main SDG applicable to HE functions is SDG 4, which aims to *“ensure inclusive and equitable quality education and promote lifelong learning opportunities for all”*. This SDG includes targets by 2030 to ensure equal access to affordable and quality tertiary education (target 4.3) and to integrate key sustainability concepts across the curriculum (target 4.7) through the Global Partnership for Sustainable Development framework (UN 2015). In this way, the UN’s 2030 Agenda consolidates the importance of the Education for Sustainable Development (ESD) initiative led by the United Nations Educational, Scientific and Cultural Organization (UNESCO), which gained traction as an important high-level

educational initiative to support the SDGs at the time of the 2012 Rio +20 United Nations Conference on Sustainable Development, following the 1992 Earth Summit in Rio de Janeiro (UNESCO 2014).

Although a sustainable HE system should fulfil HE's main functions and help to address social, economic and environmental dimensions of sustainable development, the focus in this entry is predominately on environmental sustainability. This is because the social and economic responsibilities and effects of HE, such as providing access to minority groups and disadvantaged students or meeting the educational requirements of national or local economies, are widely discussed topics in their own right, while the environmental sustainability of HE is a relatively new subject, although one in which there is a growing body of literature published, for example, in the *International Journal of Sustainability in Higher Education*. Environmental sustainability is typically measured against reductions in negative environmental impacts, energy use and greenhouse gas emissions. This is relevant to the following UN SDGs: SDG 7 "Ensure access to affordable, reliable, sustainable and modern energy for all" with reference to prioritizing energy-efficient practices; SDG 12 "Ensure sustainable consumption and production patterns"; and SDG 13 "Take urgent action to combat climate change and its impacts" (UN 2015). This entry summarizes some key approaches to promote environmental sustainability in HE, including:

- Greening the curriculum to encompass education for sustainable development;
- Greening campus buildings and site operations;
- Designing HE teaching and learning delivery systems, such as distance and online education systems, which potentially minimize impacts on the environment.

A further role that the HE system can have in improving environmental sustainability is through research on environmental science and related subjects carried out in universities and other HE institutions when transferred to and applied in society.

Approaches to Sustainable Higher Education Systems

This section introduces and discusses key HE initiatives and research studies that address sustainable higher education systems.

Higher Education for Sustainable Development

HE has a key role in the development of society and the economy and therefore HE providers have a vital role in changing current practices towards sustainable development (Alonso-Almeida et al. 2015). This may be achieved through education, research, policy formation, and information exchange to support the diffusion of environmental knowledge and literacy across society (ULSF 1990). Alshuwaikhat and Abubakar (2008) also point to the importance of HE institutions in educating most business and political leaders and professionals. Thus, the highest priority for sustainable HE systems has been on "greening the curriculum" to educate students and others for sustainable development.

Education for Sustainable Development (ESD), also known as Sustainability Education and Education for Sustainability, was established in 2005 (UNESCO 2014) and since then has propagated several HE international initiatives. The first major HE sustainability initiative is the 1990 global Talloires Declaration of University Leaders for a Sustainable Future, established by the Association of University Leaders for a Sustainable Future (ULSF), which now represents a commitment by over 500 university leaders in more than 50 countries to integrate sustainability and environmental literacy in teaching, research, operations, and outreach (ULSF 1990). This includes a commitment to educating all HE students and training HE staff in environmental literacy, as well as raising public, industry, and

government awareness of the need to move toward an environmentally sustainable future. A second key initiative is the European Copernicus Charter first established in 1993, which by 2011 with the Copernicus CHARTA 2.0 had signed up over 320 European universities. It has similar aims to the Talloires Declaration and calls for “*institutions of higher education [to] pay particular attention to their role(s) in realising processes of lifelong learning for sustainable development by involving formal, non-formal and informal learning in this direction*” (Alliance Copernicus 2011). A third international Higher Education Sustainability Initiative (HESI) was set up in 2012 as part of a multi-agency UN program with participating HE institutions, which has secured commitments from global university leaders to integrate sustainability into the curriculum as well as on campus (UNESCO 2014). In 2000, the Global Higher Education for Sustainability Partnership (GHESP) consortium was set up to bring together the ULSF, COPERNICUS-Campus, the International Association of Universities, and UNESCO as a voluntary partnership to promote sustainable development in HE teaching and research worldwide, as part of the UN Decade of ESD (Anon. 2005).

In HE there has been high levels of student demand and interest in sustainable development together with increasing inclusion of ESD curricula focused on sustainable development and the ways this may be achieved (Ryan and Cotton 2013). Although ESD curricula usually include environmental studies and/or science content, many also incorporate the social and economic dimensions of sustainable development (Sinakou et al. 2018). The learning delivery methods favored by proponents of ESD are typically student-centered pedagogical approaches, including participatory and experiential learning through reflection on action and discovery, designed to encourage critical thinking about sustainable futures and challenging current beliefs, values and assumptions about the status quo (Cebrián et al. 2015). Moreover, the phenomenon of massive open online courses (MOOCs) has been viewed as a mechanism to promote mass education in sustainable development, as well as encouraging pro-environmental behavioral changes and delivering socio-economic benefits (Lane et al. 2014).

A large body of relevant academic work on environmental and sustainability education is available in journals, notably *Environmental Education Research* and the *Journal of Environmental Education*, while the *Journal of Education for Sustainable Development* addresses innovative approaches to ESD and the impacts on students’ environmental attitudes and behaviors. Such journals offer a useful source of conceptual and empirical studies for the interested reader. However, while much more research is needed on the outcomes of ESD for students, a few research studies have already observed pro-environmental changes in student behaviors as a consequence of study on HE courses with ESD content. In one such study, students developed ideas for sustainable living and subsequently instigated behavioural changes, following measurement of their ecological footprints arising from their household use of transport, energy, shopping, the house and garden, water and waste (Roy and Caird 2001). In another study, learning about sustainable development led many students to make pro-environmental behavioural changes, for example, reducing car use, improving home energy efficiency, recycling waste or shopping for locally produced food (Roy et al. 2005).

The ambitions of ESD have not been uncontested in academic discourse. Critiques of ESD address the challenges posed around whether education should be harnessed to a specific purpose, even if the purpose is mainly well regarded, when such approaches may be construed as encouraging students to accept a doctrine and set of sustainable development values rather than to think creatively (Jickling and Wals 2012). In their book *Higher Education and Sustainable Development: Paradox and Possibility*, Gough and Scott (2007) state “...on one side, it is often argued or assumed that universities exist to provide a future society with the skills base it will require. In another view, universities exist not (merely) to service the economy but to contribute to the intellectual and moral improvement of the human condition.” These authors pose the question of whether HE can achieve

sustainable development goals and also produce educated independent thinkers. Shephard (2015) identifies concerns among academics about sustainability advocacy as an important factor in explaining HE institutional barriers to offering ESD curricula. However, while further considerations and resolutions are required, the adoption of innovative pedagogical approaches with an emphasis on developing critical and future thinking in ESD should go some way toward overcoming such institutional barriers (Cebrián et al. 2015). These authors also identified the importance of institutional strategies to promote academic engagement with ESD, including organizational support and leadership, quality assurance processes, professional development, and establishing reward structures. Moreover, following Gough and Scott (2007), many academics regard ESD as essential to achieve sustainable development, although problematic for HE.

Greening Campus Buildings and Site Operations

A second major approach to making HE systems sustainable focuses on “greening the campus”. This includes ensuring the energy and resource efficiency of campus buildings and improving environmental management of campus site operations, such as reducing water consumption, pollution and waste (e.g. Sorrell et al. 2000; Williamson 2012; Robinson et al. 2018). Alshuwaikhat and Abubakar (2008), for example, recommend that *“a sustainable university campus should be a healthy campus environment, with a prosperous economy through energy and resource conservation, waste reduction and an efficient environmental management....”*

Greener campuses and site operations as part of sustainable HE systems have been promoted in various national, regional, and international institutional partnership initiatives. Several HE initiatives, some of which are mentioned above, include the Talloires Declaration, which represents a commitment to integrate sustainability into campus site operations as well as in teaching and research. One of the Declaration’s actions is to *“Set an example of environmental responsibility by establishing institutional ecology policies and practices of resource conservation, recycling, waste reduction, and environmentally sound operations”* (ULSF 1990). Similarly, the HE institutions participating in the HESI initiative led by several UN agencies have committed to supporting “green campuses and local sustainability efforts” (UNESCO 2014). Moreover, the COPERNICUS Charter for sustainable development has similar aims to these international initiatives concerning the incorporation of sustainability practices into universities, which includes greening campuses. It is also notable that countries and continents have their own associations and programs for developing sustainable HE systems, such as North America’s Association for Advancing Sustainability in Higher Education (AASHE) established in 2005, which includes among its activities the development of sustainability performance measurement, resources and toolkits (see e.g. Urbanski 2017).

Such initiatives are only effective, however, if followed by an implementation plan. A good example is the Australian National University’s Environmental Management Plan whose sustainability targets for 2021 relative to a 2014 baseline, include plans to: decrease total carbon dioxide emissions by 30%; increase renewable energy generation by 50%; increase the recycling rate to 85%; reduce emissions of key pollutants by 25%; reduce water use per person by 50%; increase sustainable commuting to 80%; offset 100% of air travel emissions; and conserve all protected ecological communities, habitats and species on campus (Australian National University 2017). Another example is Groningen University, a pioneer institution in the COPERNICUS Charter initiative, which developed a 2015-2020 Roadmap based around the aims of the university to be carbon neutral by 2020 through a program of energy efficiency, renewable energy, green buildings, waste reduction and separation, and water conservation (University of Groningen 2018).

Many HE institutions have now established sustainability policies to manage campus and site operations, for example, concerning building construction and operations, procurement processes,

the efficiency of information and communication technologies (ICT) systems, pollution control, and water and waste management (Caird et al. 2015a). While sustainability reporting is in the early stages and only supported by relatively few mainly European universities in the international context (Alonso-Almeida et al. 2014), the growing commitment to sustainability is evident from university websites, where many universities have policies aimed at preserving green spaces, wildlife and biodiversity in campus design and planning (University of Durham 2018; University of Edinburgh 2018; University of Southampton 2018). Moreover, under the worldwide Greenhouse Gas Protocol Initiative, HE institutions are obliged to report on carbon management, including (Scope 1) direct carbon dioxide emissions from sources that they own or control, such as heating and cooling buildings, (Scope 2) indirect carbon dioxide emissions from the generation of electricity purchased by the institution, and (Scope 3) indirect emissions that arise from the impact of activities outside institutional ownership and control, such as staff and student travel, water supply, waste disposal, and supply chain procurement (WRI/WBCSD 2014).

It is generally recognized that activities giving rise to Scope 3 emissions are the most difficult areas for HE systems to manage, not being under direct institutional ownership and control (Caird et al. 2015a; Versteijlen et al. 2017). This is demonstrated by Townsend and Barratt (2015) who measured the carbon footprint of Leeds University, UK to identify the Scope 3 emission hotspots. The areas producing the highest greenhouse gas emissions across supply chains were utilities and construction, followed by purchase of machinery, computers and manufactured products, transport and communication. They also summarised the results of carbon footprint studies in six other universities world-wide, which showed that Scope 3 emissions dominated those produced, and the major carbon impact areas in these universities were building construction and travel.

Versteijlen et al. (2017) calculated staff and student travel to be the main component of Scope 3 carbon dioxide emissions accounting for 40-91% of the total emissions of six Dutch universities. Similarly, high emissions from staff and student travel were also reported in university case studies in the UK (Ozawa-Meida et al 2013) and USA (Bailey and LaPoint 2016). In response, some HE institutions have introduced sustainable transport plans, for example, promoting the use of bicycles and providing access to public transport for staff, students and visitors and discouraging single-car commuting through car sharing and parking restrictions, for example, the University of Bristol (2017) and the University of Nottingham (2018). A particular concern is with the emissions from international air travel, which is associated with HE aspirations for the expansion of their numbers of international students (Davies 2015). Preliminary research by Fawcett (2005) indicates that carbon equivalent emissions from international students' air flights to and from the UK are comparable to the carbon dioxide emissions from the whole HE sector's building stock. Fawcett observes that *"there is little evidence that the sector has begun to acknowledge the additional damage to the climate involved in recruitment of international students."*

Sustainable HE Teaching and Learning Models

Approaches to improving the environmental sustainability of HE systems may be broadened beyond greening campuses and the curriculum to include the design of teaching and learning delivery systems. Very few studies have examined this approach to HE system sustainability (Alharthi, Spichkova and Hamilton 2018). The first major quantitative research to examine how the design of HE delivery systems impacts on the environment was the "Factor 10 Visions" study "Towards Sustainable Higher Education" (Roy et al. 2005). This conducted an environmental audit of 20 full- and part-time HE courses in the UK institutions to include staff and student travel; the purchase and use of computers, printed educational materials, and paper; student residential energy use; and campus buildings and site operations. This enabled an assessment of the energy use and carbon

dioxide emissions involved in the production and delivery of campus-based and distance HE courses. The campus-based courses were delivered through traditional face-to-face teaching, whereas the distance HE courses were delivered either by mainly print-based materials or by blended print and online materials both with some supportive face-to-face, telephone, or online tuition.

The “Factor 10 Visions” study found that on average the production and delivery of the distance HE courses used 87% less energy and produced 85% fewer carbon dioxide emissions than the campus-based courses when standardized per hundred student hours of planned teaching and learning. The much lower impacts of distance learning compared to campus-based courses are mainly due to a major reduction in the amount of student travel, economies of scale in utilization of the campus site, and the elimination of much of the energy use associated with students’ accommodation. The courses with online provision appear to offer only a small reduction in energy use and carbon dioxide emissions (20% and 12%, respectively) when compared to mainly print-based distance learning courses. This is due to high student use of computing and consumption of paper for printing off online material (Roy et al. 2008).

These significant results were submitted to the Higher Education Funding Council for England (HEFCE) as part of its consultations on sustainability in the HE system. However, perhaps because the results were considered most applicable to distance HE systems, HEFCE did not give priority to recommendations around increasing the use of distance teaching and learning in promoting HE system sustainability. Instead the previous two approaches discussed earlier – greening the curriculum and the campus – were viewed as more relevant, at least in the UK system (HEFCE 2010).

With the proliferation of ICTs transforming HE over the past two decades, there was a need to revisit questions concerning the design and environmental impacts of HE teaching and learning delivery systems. The “SusTEACH” project extended the “Factor 10 Visions” study to examine the pervasive use of ICTs in transforming HE teaching and learning and the likely impacts on energy use and carbon dioxide emissions. This study first developed a new classification of HE courses and modules in the UK institutions based on their primary teaching and learning model (Caird and Lane 2015), and then conducted an environmental assessment and analysis of the energy use and carbon dioxide emissions involved with different teaching and learning models of course and module production and delivery (Caird et al. 2015b). The SusTEACH study, which surveyed 19 campus-based and 11 distance learning courses and modules, supported the findings of the previous study on the main uses of energy and sources of carbon dioxide emissions involved in producing and delivering UK HE. Moreover, the aggregated results showed that distance HE teaching and learning models (which included print-based distance-taught models, blended ICT-enhanced distance-taught models, and online models) reduced average energy use by 88% and achieved average reductions in carbon dioxide emissions of 83% when compared with campus-based HE models (which included traditional face-to-face models and blended ICT-enhanced face-to-face models), again when standardized per hundred hours of student teaching and learning (Caird et al. 2015a). A comparison of distance and campus-based HE systems showed that the distance learning provision on courses and modules was the most important factor in explaining the major differences in the resultant uses of energy and consequent carbon dioxide emissions. As with the “Factor 10 Visions” study, the strikingly lower impacts of distance learning were mainly due to a significant reduction in student travel and residential energy use, and efficiencies of scale in utilizing campus site facilities and operations (Roy et al. 2008; Caird et al. 2015a).

Addressing the specific role of ICTs in HE models of course production and delivery, the SusTEACH study also calculated the average energy use in megajoules (MJ) and carbon dioxide emissions in kilograms (kg) associated with HE teaching and learning models standardized per student per

hundred study hours. The SusTEACH research findings showed that the energy and emissions impacts were *from lowest to highest* as follows:

Online models	363 (MJ) and 36 CO ₂ (kg);
Blended ICT-enhanced distance models	501 (MJ) and 45 CO ₂ (kg);
Print-based distance models	623 (MJ) and 49 CO ₂ (kg);
Blended ICT-enhanced face-to-face teaching models	4259 (MJ) and 246 CO ₂ (kg);
Traditional campus face-to-face models	4293 (MJ) and 278 CO ₂ (kg)

These results showed that online and blended ICT-enhanced HE models were comparatively better than the print-based distance teaching models at reducing the main sources of energy use and therefore achieved significant carbon reductions. The picture was more complex in campus-based HE systems when examining blended ICT-enhanced face-to-face teaching models, which only achieved slightly lower impacts than traditional campus models. Where ICTs are used to design courses and modules to reduce the need for student travel and commuting, and to reduce the use of residential and campus buildings and facilities, then significant reductions in energy use and carbon dioxide emissions can be achieved. However, the analysis of the SusTEACH findings revealed that a third of the energy use and carbon dioxide emissions associated with the blended ICT-enhanced campus model was attributable to student air travel between home and term-time residence. In some cases, this blended model involved students traveling long distances to attend the campus for short periods of face-to-face teaching, while also learning online for part of the course. As discussed in the Section “Greening campus buildings and site operations”, HE aspirations to increase the numbers of international students raises significant sustainability concerns, although the likely carbon dioxide emissions generated by international student air travel is rarely discussed (Davies 2015).

Very few other studies comparing the environmental impacts of different models for delivering HE teaching and learning exist. One of the few is Harlow’s (2016) case study comparing the environmental impacts of online and on-campus students associated with travel, campus and residential energy use, and use of ICTs and paper at the University of Waikato, New Zealand. This used a slightly different methodology but broadly supported the findings of the UK Factor 10 Visions and SusTEACH studies. This study showed that the online delivery model achieved reductions in energy use (approximately 60%) and carbon dioxide emissions (72%) compared with the on-campus model. The relatively lower reductions achieved compared with the UK studies were attributable to the New Zealand context, where the national energy mix includes a high proportion of renewable sources, where climatic factors reduce energy demand, and where geographical factors result in shorter journeys for teaching and learning (Harlow 2016).

In a US study focused on student travel, Campbell and Campbell (2011) surveyed 500 students enrolled on online courses provided by three Californian university campuses. The students were asked to estimate their reduction in car use as a result of studying online compared with attending on-campus. The results indicated savings of 50-100 kg of carbon dioxide emissions per semester per student. The survey also found increased student satisfaction with studying online due to the reduced environmental impacts but noted that although the number of US students learning online was growing, senior faculty members in American universities were still generally resistant to online courses (Allen and Seaman 2010).

Another study by Oliveira et al. (2017) noted a significant increase in the use of distance education in Brazil in order to widen participation, including through reaching students in areas not served by conventional HE institutions, and to reduce costs. They then modelled the energy use per student in delivering a technical management course via face-to-face campus and online distance education systems. The result was that the online education system used about *twice* the energy of the campus-based system. This finding was due to the “emergy” energy accounting technique used (Odum 1996); the assumption that staff and student travel to campus was all via a fixed bus route that used less energy than the computers required for the online system; and, that only a few more students were taught online than by the campus system. However, the study found that as student numbers on the course increased, the online system began to use less energy than the campus one with a crossover number of 300 students. So, while some of these results seem to run contrary to those of the other studies mentioned above, they point to the methodological complexities and contextual factors involved in making such comparisons. Nevertheless, like the other studies, this one demonstrates the value of scale economies that may be gained through the use of distance and online course delivery.

A limitation of the studies comparing distance, blended, and campus-based HE systems is that they focus on energy use and carbon dioxide emissions while ignoring other environmental impacts, such as resource depletion, air and water pollution, threats to wildlife, and waste. However, some studies have shown that energy use and carbon dioxide emissions are often a good indicator of these other environmental impacts (e.g., Kalbar et al. 2017), and so reducing energy use and carbon dioxide emissions will often result in a reduction in other negative impacts.

Conclusion

This entry has examined sustainable HE systems and several contemporary initiatives that support sustainability in terms of both the main functions of HE and its internal operations. It has focused on the environmental sustainability of HE systems, with particular reference to reducing energy use and carbon dioxide emissions. Existing HE sustainability initiatives have focused predominately on “greening” the curriculum through Education for Sustainable Development initiatives and “greening” campus buildings and site operations through institutional sustainability policies and practices. However, the authors of this entry also argue that such current initiatives should be broadened to consider the design of teaching and learning models for course production and delivery to support sustainable development. Until recently, there has been little attention to sustainable HE teaching and learning models and how the use of ICT and distance learning can reduce negative environmental impacts.

This entry has focused on empirical studies of the benefits of online and distance HE systems for reducing energy use and carbon dioxide emissions with reference to SDGs 7, 12, and 13 (UN 2015). Online and distance HE systems can also have wider benefits across social and economic dimensions of sustainability, beyond the environmental dimension, offering the potential to promote social sustainability, for example, by increasing the availability, accessibility, affordability and equity of HE with reference to SDG 4 “Ensure inclusive and quality education for all and promote lifelong learning”, as well as promoting economic sustainability, for example, by improving system efficiencies, economies and effectiveness with reference to SDG 12 “Ensure sustainable consumption and production patterns” (UN 2015). This is achieved by widening access to learning beyond the campus context, achieving scale economies and scale efficiencies by spreading costs across larger student numbers, and substituting the main uses of energy and sources of carbon dioxide emissions using distance methods and ICTs.

In conclusion, initiatives that attempt to reduce HE energy use and carbon dioxide emissions have a valuable role in achieving sustainable HE systems. In particular, it is recognized that staff and student travel, building construction, campus site operations and procurement, and student residential buildings are the main sources of energy use in the HE system. Hence reducing carbon dioxide emissions should be achieved through substitution and reduction measures focused on these areas, and key ways of achieving this include greening campus buildings and site operations, making greater use of distance and online HE teaching and learning systems, and educating students to understand how they can contribute to sustainable development.

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