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Review of the teaching of sustainability in UK engineering higher education

UCL Centre for Engineering Education

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Contents

Foreword
by Professor Tim Ibell FREng

This UCL Centre for Engineering Education review of the teaching of sustainability in UK engineering higher education is simultaneously important and terrifying, in equal measure. Either way, it is a must read for educators, accreditors, and policy makers.

This review demonstrates starkly just how far off the mark the engineering higher education sector is in embedding sustainability in our degree programmes, given that engineers will have to play a major role in solving the global issues we face. This review shows that you wouldn't believe that engineers had much to offer at all if sustainability is not yet considered to be centrepiece in every aspect of engineering education.

Sadly, it is often the case that not much changes in life until someone mandates change. This is the role and responsibility of accreditation bodies. It is why this review has highlighted so clearly in Table 1 the deficiencies and disparities which exist across our accreditation bodies in addressing sustainability properly. I find this excellently compiled table rather frightening, and I hope others do too. Alone, this gem of a table should underpin rapid action in accreditation bodies – I certainly hope it does. Despite the well-stated limitations in only searching for single words, this table represents a sad indictment on our engineering education system.

Nuggets of good practice are always good for the soul after reading something like Table 1, and they are indeed very welcome. My feeling, however, is that occasional nuggets don't fulfil anything systematically. What is really needed in place of bolt-on nuggets is a rich seam throughout every degree programme in which every single assessment is 'velcroed' to the notion of sustainability. This requires contextual education to ensure that the very first thoughts of any engineer when considering any sort of engineering problem is holistic sustainability of the solution. Without this attribute implanted in our graduates, our engineering profession will not be as empowered as it should be to lead global responsibility in all the challenges we face. Indeed, without this attribute implanted in our graduates, our engineering profession is utterly irrelevant in future.

This review tells me that we are nowhere near this required attribute as a legacy of the education of our engineers, and that fundamental change is needed more than ever. Thank you, UCL, for writing this review, and I hope it impacts all who read it as much as it has impacted me.

Professor Tim Ibell
FREng CEng FIStructE FICE FHEA

Royal Academy of Engineering
Engineers 2030 Working Group
Dean of Engineering, University of Bath

A fundamental shift in the framing of the engineering curriculum is needed

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Introduction

Scientists widely acknowledge that the world is facing a climate crisis. What is less widely acknowledged, but absolutely fundamental is the role of engineers in addressing this.

The responsibility is two-fold. We must first acknowledge that while engineering has delivered huge benefits to humankind through many technological advances that have improved the standard of living, and much of that change has not been sustainable or without significant environmental impact. Over the past two decades many calls have been heard for much more focus on the societal impact of engineering, especially in the education of our future engineers.[1] Such calls emphasise the need for engineering students to clearly see their societal responsibilities as practicing engineers and to challenge existing design paradigms if they are unsustainable.

The second area of responsibility is as part of the solution to the climate crisis. This perhaps has received more emphasis as it provides a more comfortable narrative. Engineers, although certainly not engineers alone, will be at the heart of slowing climate change and hopefully, even potentially reversing it. Our current and future graduates will be the champions of green energy, sustainable cities, zero-carbon transport, carbon-neutral food production as well as supporting technologies such as telepresence and reducing reliance on energy-heavy mined minerals and metals such as lithium.

It is the authors' opinion that to achieve these goals a fundamental shift in the framing of the engineering curriculum is needed. As this report hopes to show, there are signs of significant progress, and evidence of good practice and support from accreditation bodies to drive this change, but much more action is needed.

Sustainable design is not an abstract concept. It is not one that sits in its own module separate from the technical details of a discipline. It is a core consideration and one that needs to be recognised as an absolutely fundamental concept from the very earliest stages of all degree programmes and repeated at regular intervals right the way through. Far too often it is an afterthought in the design process[2] – something that is checked for compliance at an advanced stage of the design rather than an innate consideration at every stage.

In training the next generation of engineers and engineering leads it is beholden on us as educators to rectify this deficient view.

Background to the study

The UCL Centre for Engineering Education in collaboration with the Engineering Professors' Council prepared this report outlining sustainability teaching as part of a wider piece of work on the current landscape of engineering education in higher education within the UK.

This work looks to draw out the current level of, and common approaches to, the teaching of sustainability in engineering disciplines.[3]

The work includes a desk-based review of literature and university websites as well as a survey undertaken with university leaders (deans, vice-deans education, heads of department and heads of teaching) across the UK in the summer of 2022. The survey has highlighted that the majority of respondents felt that there is pressure to increase the amount of teaching dedicated to sustainability / sustainable development[4] within their programmes.

When asked: "is there a pressure from your faculty / school for engineering departments to increase teaching of sustainability / sustainable development in their programmes?" 85.7% of the survey participants responded yes. In part, this is in response to the changes coming in via accreditation and Accreditation of Higher Education Programmes, 4th Edition (AHEP4).

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Sustainability and accreditation

There have been calls for some time for accreditation to take a lead in promoting sustainability in engineering curriculums.

In 1997 in Paris, the joint conference on engineering education and training for sustainable development called for professional engineering institutions to adopt accreditation policies that require integration of sustainability in engineering teaching at all levels from foundation courses to ongoing projects and research.[5]

In AHEP 3 sustainability appeared in two of the learning outcomes. Taking the requirement at MEng Level it first appears with the economic, legal, social, ethical, and environmental context (EL) section in criteria EL4 – "Understanding of the requirement for engineering activities to promote sustainable development and ability to apply quantitative techniques where appropriate." It also appears in the Design (D) set of criteria, D2i: "Investigate and define the problem, identifying any constraints including environmental and sustainability limitations; ethical, health, safety, security and risk issues; intellectual property; codes of practice and standards."

Analysis of the AHEP4 – which is now coming into force for accredited degree programmes in engineering across the UK – shows that sustainability now has its own dedicated line (as part of reduced set of learning objectives) appearing only once in 'The engineer and society' section as a requirement M7: "Evaluate the environmental and societal impact of solutions to complex problems (to include the entire lifecycle of a product or process) and minimise adverse impacts."

Here the phrasing of evaluate is interesting. Although 'Evaluate' is the penultimate level in Bloom's Taxonomy of learning objectives, some may wish that the expectation goes further. It should be noted that although there is now only one learning outcome for sustainability in AHEP4, this is part of a more concise and focused set with sustainability specifically highlighted in the accompanying narrative as an area that has been strengthened.

The 2023 released Quality Assurance Agency for Higher Education (QAA) draft *Subject Benchmark Statement for Engineering*[6] puts far more emphasis on what it refers to as 'education for sustainable development', making specific reference to the UN Sustainable Development Goals (SDGs).

The Joint Board of Moderators (JBM), the accreditation organisation that offers combined accreditation in the UK for the Institution of Structural Engineers, the Institute of Highway Engineers, the Chartered Institution of Highways and Transportation, the Permanent Way Institution and the Institution of Civil Engineers has provided specific extra requirements in its guidelines for developing degree programmes under AHEP3.[7] Detailing the knowledge, intellectual ability, and skills required in this area it has the aim that: "Students will become attuned to the need to design and engineer projects which minimise our negative impact on the environment, and which enhance humankind's endeavours in a sustainable manner. Students will understand that their interventions should minimise the temporary borrowing of finite-resource material, while maximising societal benefit."

Comparison with international accreditation

Internationally a survey of learning outcomes related to sustainability show that there is broad engagement from professional bodies but that there is still a need for an integrative approach that had been a struggle to gain traction in the engineering curriculum.[8]

Drawing on the excellent work of Ed Byrne from the University of Cork we can see that although the scope and breadth of the sustainability related criteria has clearly increased across most of the professional bodies, there is still some significant variation.[9]

Professor Byrne's analysis identified nine categories of activity or attributes that may be contained within the accreditation documentation and that may relate to the inclusion of elements of sustainability within the curriculum[6]:

1. **Sustainability / Sustainable / Sustainable Development / United Nations Sustainable Development Goals (UN SDGs)**
2. **Equity / Equality, Diversity, Inclusion (EDI / DEI)**
3 **Ethics / Ethical / Global**
4. **Environmental / Environment**
6. **Society / Societal / Social**
7. **Cultural / Multicultural**
8. **Multidisciplinarity / Interdisciplinary / Transdisciplinary**
9. **Complex Systems / Complex / Complexity**

Table 1 draws from and extends this analysis to show the variation in the number of references to each of these areas.[10]

Table 1: Analysis of occurrence of sustainability terms in accreditation documentation. Draws data from [7]

	Sustainability / Sustainable / Sust. Dev./ SDGs	Global	Environment	Society / Societal / Social
ABET (2022–23)	1	2	2	3
EUR-ACE (2021)	1	2	4	9
Engineers Australia (2019)	12	1	6	7
Engineers Ireland (2014)	4	0	7	11
Engineers Ireland (2021)	12	1	14	15
Engineering Council AHEP4 (2020)	8	0	7	13
IChemE (Aug 2017)	12	0	23	9
IChemE (Oct 2021)	29	4	32	35
IET (2015)	2	0	7	6
IMechE – AHEP3 (nd)	3	0	3	2
IMechE - AHEP4 (nd)	1	0	3	3
JBM – AHEP3[5]	31	0	18	18
JBM - AHEP4	31	7	22	18

As noted by Byrne on p25: "The number of times a word is mentioned does not of course confer absolute importance (including relative to other terms) as seen by a professional body in terms of requirement for integration into a programme."[6]

To consider this we also looked at the prominence of sustainability issues to see if it occurs as a headline in the accreditation criteria or merely as an element within a category (see Table 2).

Table 2: Analysis of Sustainability as core criteria in accreditation documentation

Accrediting body	Sustainability as part of a high-level criteria	Sustainability as its own high-level criteria	Notes
ABET (2022–23)	No	No	Sustainability is an item within a list of design criteria
EUR-ACE (2021)	No	No	Mentioned as a criteria in Making Judgements, Communication, and Team-working
Engineers Australia (2019)	Yes	No	Included as part of the requirement "Understanding of the scope, principles, norms, accountabilities, and bounds of sustainable engineering practice in the specific discipline." Mentioned at several points within Knowledge and Application
Engineers Ireland (2021)	Yes	Yes	On the front page "A community of creative professionals delivering sustainable solutions for society" One of seven 'Programme Areas' – PA7 Sustainability
Engineering Council AHEP 4 (2020)	Yes	Yes	Sustainability is its own criteria in The engineer and society section
IChemE (Oct 2021)	Yes	No	As a high-level criteria combined with ethics – A2.7 Sustainability and Ethics
IMechE – AHEP4 (nd)	Yes	Yes	Follows AHEP4 with sustainability as a separate criteria
JBM – AHEP4	Yes	No	High-level criteria and separate Annex (C) on detailed expectations

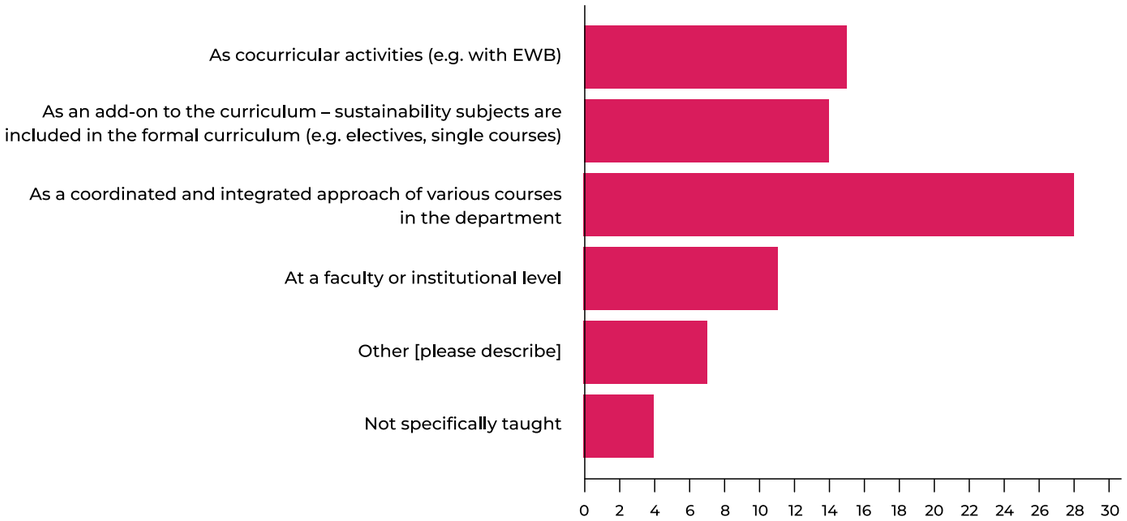
Teaching sustainability in engineering in the UK

Sustainability in the curriculum

In most cases, survey respondents report that sustainability is taught as a coordinated and integrated approach in various courses at a department level.

Some institutions teach sustainability at a faculty or institutional level, as a cocurricular activity, for example in collaboration with Engineers without Borders UK (EWBUK), and as an add-on to the curriculum (see Figure 1).

Figure 1: Response to the question "How is sustainability taught at your institution / department?"



Despite the survey responses, this review would suggest that although staff may see the development of sustainability in the curriculum, this integration may mean that it is hidden, at least to the outside world via publicly available documents. It is our contention to effectively promote a positive image of engineering we need to make sustainability education visible and pervasive across our curriculums.

A desk-based study of the publicly facing webpages of the 20 largest engineering university cohorts was undertaken. The universities account for approximately 50% of the FTE (Full-time equivalent) undergraduate student number in the UK, according to the Higher Education Statistics Agency (HESA) data. The generic MEng programmes in chemical engineering, mechanical engineering, electronic and electrical engineering, and civil engineering were considered, or the nearest variant. The variety of information available ranged from high-level précis of the entire programme to detailed programme specifications and module paperwork.

The aim of the desk research was to determine what content relating to sustainability was available to students. From the fact that all programmes considered are accredited by the UK Engineering Council under AHEP3, it should be a not unreasonable assumption that sustainability is covered at some point given the requirement that students should be able to:

"Investigate and define the problem, identifying any constraints including environmental and sustainability limitations; ethical, health, safety, security and risk issues; intellectual property; codes of practice and standards."

In addition, the Engineering Council produced a separate "Guidance on Sustainability for the Engineering Profession" targeted at the practicing engineer.[11]

However, it is clear that this requirement is addressed in very different ways, from the very upfront and obvious to the more subtle. In the extreme, for some courses no mention of sustainability could be found in the publicly available descriptions; any absence for any provider may represent anything from a truly embedded approach to total ignorance.

There is an interesting split between disciplines. In the majority of civil engineering programmes sustainability is a clear element of the programme articulated in the high-level summary of the programme aims. As mentioned above, the targeted approach of the JBM may well be a key factor in this. An initial search suggested that more than half of chemical engineering programmes considered environmental issues. However, it is not clear if it is aligned to sustainability in the broader sense. Further investigation of a selected set of modules suggest that this more aligns with 'HazOps' – the identification of potential risks to environment from operations, rather than the sustainable development of overall processes. The research show that mechanical engineering is less likely than civil engineering to explicitly mention sustainability as a high-level aim or outcome for their programme.

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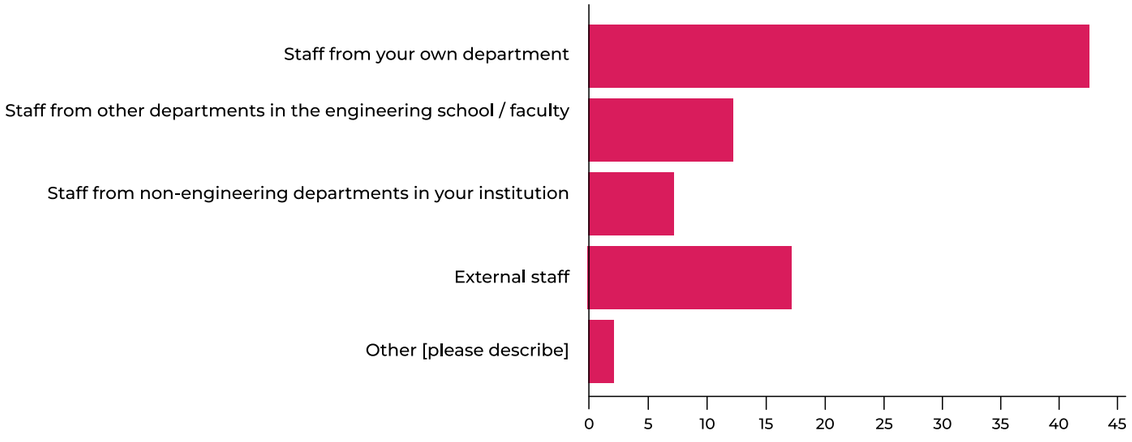
The summaries available show that explicit material relating to sustainability is far less prevalent in electronic and electrical engineering programmes, where few make such overarching statements. The same is true of courses in software engineering, with less than 15% mentioning sustainability in their high-level summary and only 20% showing explicit sustainability in their core curriculum. Looking at the detail of the programme curriculums (where this is available – and it should be noted the level of detail publicly accessible varies greatly), modules with clear sustainability threads (either core or as options) are considerably more common in civil and chemical engineering than any other discipline. It is, however, common in both electronic and electrical engineering and software engineering to see professional practice modules. These typically refer to the context of engineering and require students to gain an "appreciation of the social, ethical, and legal considerations of the discipline". Therefore, it might be expected that sustainability content would be found here although this is not currently explicit. With emissions related to digital activities projected to be 14% by 2040 if we miss this sector out of the analysis we won't have accomplished our goal.

Who is teaching sustainability?

As part of the survey, we asked: "Who is involved in teaching sustainability / sustainable development?"

The response (see Figure 2) suggests that most teaching is conducted by in-house staff (staff from own department), followed by external staff, and staff from other departments in the engineering faculty / school. In some cases, staff from nonengineering departments are also involved, but on a much smaller scale.

Figure 2: Response to the question "Who is involved in teaching sustainability / sustainable development?"



Use of the UN Sustainable Development Goals

In most cases (71% of respondents), the teaching of sustainability/sustainable development is connected to specific Sustainable Development Goals (SDGs) (see Figure 3).

The SDGs more prevalent in engineering Higher Education Institutions' (HEIs') teaching and learning approaches are: SDG7 (Affordable and clean energy); SDG11 (Sustainable cities and communities); SDG13 (Climate action); SDG6 (Clean water and sanitation); and SDG9 (Industry, innovation, and infrastructure) (see Figure 4).

Figure 3: Does your department connect teaching of sustainability / sustainable development to specific SDGs? (N=42)

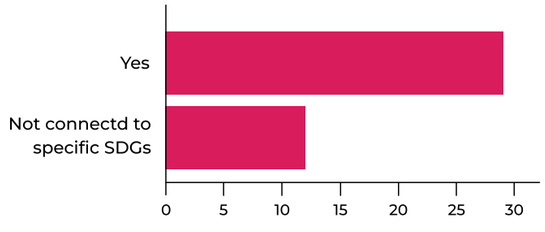
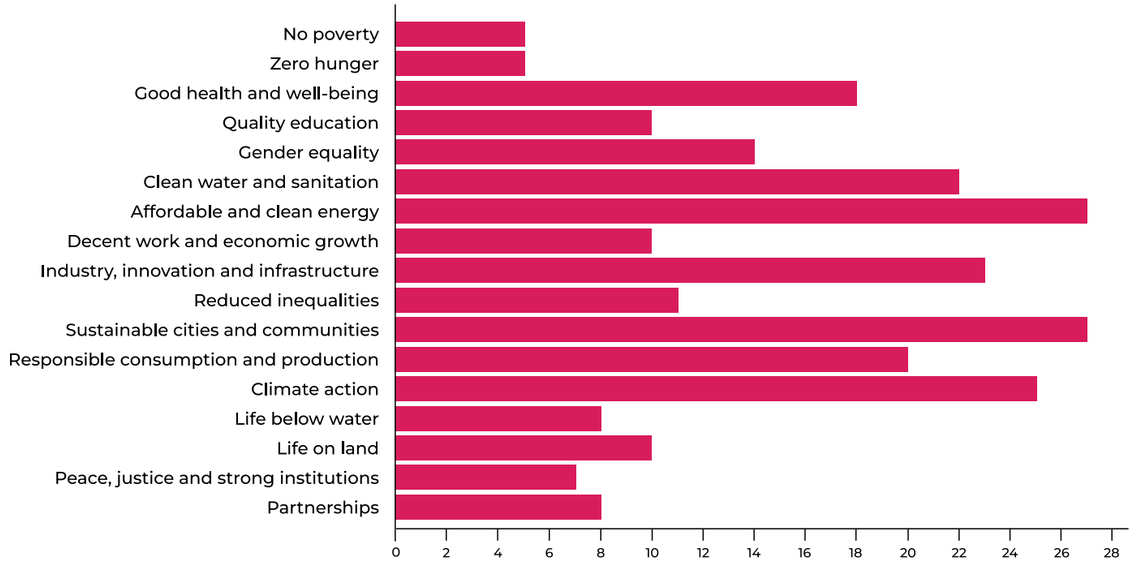


Figure 4: Most prevalent SDGs in engineering education



In the survey responses, one department reported a practice of mapping of modules against SDG goal 'Engagement with central sustainability education resources' which provides an interesting model for ensuring coverage across a programme.

It should also be noted that some institutions teach sustainability at a faculty or institutional level. This is typically through large cross-department project activities, for example, How to Change the World [12] at UCL or Global Engineering Challenge Week [13] at the University of Sheffield.

Several of these are linked to EWBUK's Engineering for People Design Challenge.[14] In this programme different universities sign up to participate although they may have different ways to deliver the design challenge – ranging from a week-long intensive study to one semester to a full academic year.

EWBUK currently have 47 universities that participate in Ireland, South Africa, the UK, and the US (over 30 in the UK and Ireland), reaching about 10,000+ students per year.

While these are undoubtedly excellent activities that will expose students to problems that are concerned with issues of sustainability, a distinction should be drawn to the systematic development of technical skills that allow students to develop sustainable solutions in their professional practice. To undertake the former, a wide-spread and holistic curriculum review is required to ensure sustainability and the practice of sustainable development is present at various, appropriate points within the curriculum [15] in an integrated way.[16]

Responses to the survey at faculty level reported that increasingly universities are developing sustainability strategies that not only include their own operations, but also encompass the requirement of addressing sustainability within their teaching. For example, the Manchester Metropolitan Sustainability strategy was launched this year committing the university to having "Sustainability underpinning everything we do" by 2026. As a result of this the institution has committed to embed sustainability across every single programme in the university.

Another approach highlighted was the inclusion of a consideration of sustainability into final year / major projects and including it in the marking criteria. Depending on the project this may take many forms, for example: students considering asset management including whole life cycle assessment; and carbon footprinting including energy use and efficiency, for example in power systems and construction projects.

Where students undertake design projects, one empirical approach required groups of students to include a consideration of impact, including: social/environmental aspects supported by learning about materials selection and alternative materials; inclusion of circular economy tasks; and consideration of waste minimisation and re-use. Some programmes required students to complete sustainability audits as part of the design process.

The need to adopt an integrated approach was clearly stated by institutions / respondents who do not teach sustainability specifically. Some respondents highlighted approaches that embedded in sustainability in core courses, but also as standalone (compulsory) courses, throughout Years 1 to 4. Other respondents described nonintegrated approaches involving cocurricular activities (for example, with EWBUK), or add-ons to the curriculum.

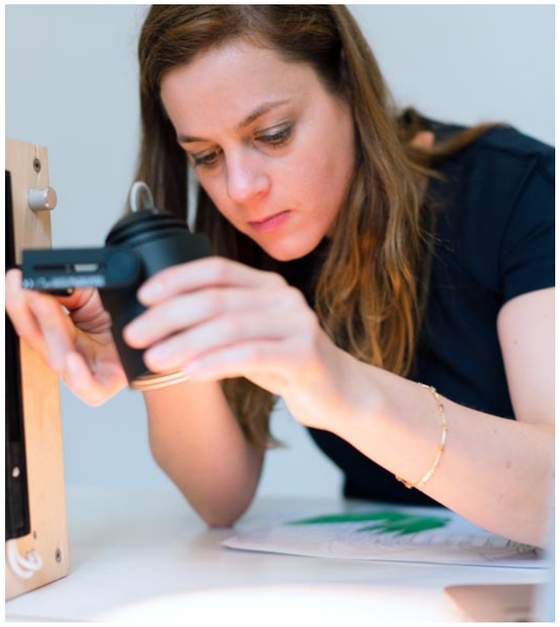
Others noted that the integrations had been achieved in other parts of their institution and observed that it is often a topic or fragment within technical content of a module. Succinctly put: "it is hard to have only a specific module that can deliver such content. We need to embed this inside areas so that students will see the direct relevance of the content." It was also observed that this process of integration is, in some institutions, underway through revalidation of modules.

Sustainability-focused programmes

At undergraduate level there are relatively few programmes that have a specific and overarching theme relating to sustainability.

Many are 'with' degrees where sustainability is a specialism within a core discipline that is chosen and studied in the latter years of the programme. Using the Engineering Council's Recognised course search [17] it was apparent that although several programmes remain and there have been new programmes started in recent years, there have also been several programme closures. This has typically been the 'with sustainability' options. There are several possible reasons for this. Recent years have seen many universities look to limit the number of programmes on offer and shift specialist programmes to themes within existing programmes to enable more flexibility for students. It may also arise from sustainability being seen as something for all programmes rather than being limited to a limited few.

Only ten distinct programmes (not counting BEng and MEng separately or variants of each, such as with year abroad or 'with' programmes) could be identified: one in building services and sustainable engineering; and the rest relating to variants of, renewable energy / renewable energy engineering.



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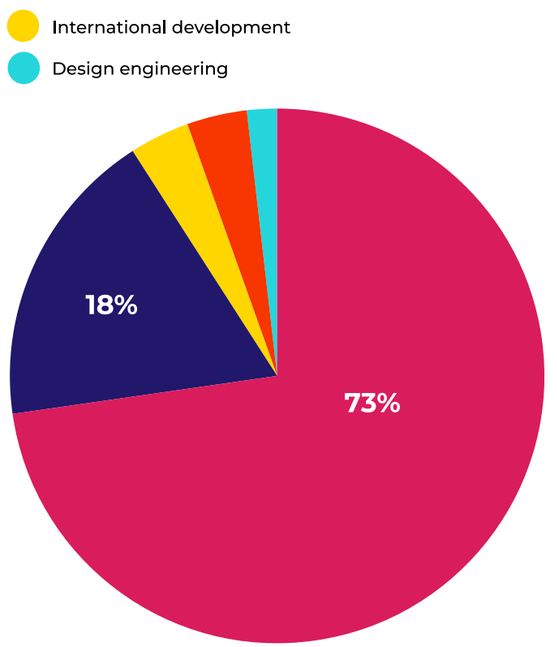
At the postgraduate level, as expected there were a much wider range of programmes that have sustainability in the title or as a central theme to degree. Outside of engineering there are a large number of programmes which reference (in the title or keywords) sustainability. Many of these are at business schools with areas such as sustainable development or sustainable finance being very well represented. Across architecture and the built environment there is also a significant breadth of offering, with topics such as: sustainable urbanism; health, wellbeing and sustainable buildings; sustainable planning and sustainable heritage available to students.

Using the Engineering Council's Recognised Course Search [27], 57 accredited and currently running programmes in the UK were identified (see Figure 5). Search terms included variants on 'sustainable' and 'renewable' with programmes based at overseas campuses excluded.

The majority of programmes focus on renewable power and energy generation systems with some notable specialisms, for example, offshore renewable energy at the University of Plymouth. The second largest area of concentration is related to infrastructure and built environment. Additionally, one of two courses were observed that focused on materials, manufacturing, and design as well as international development and humanitarian engineering.

Figure 5: Areas of interest of UK PGT provision with a core focus on sustainability in engineering



Some respondents noted that it is hard to have only a specific module to deliver sustainability content: “We need to embed this inside areas so that students see its direct relevance.”

Case studies of good practice

A few specific examples of good practice were highlighted in the survey and through the desk research:

The University of Manchester

The University of Manchester has a dedicated University Academic Lead for Sustainability Teaching and Learning appointed to lead “‘Informed and Inspired Futures’… with the aim to underpin all of our research, teaching and operations with Education for Sustainable Development working across the University and beyond.” They are also providing multiple resources / guidance on how to embed sustainability in teaching and learning as well as documents, seminars, and scholarships.

The New Model Institute of Technology and Engineering (NMITE)

NMITE was designed with an emphasis on sustainability in the curriculum from its inception. It includes the Centre for Advanced Timber Technology, a transformative learning space and industry-leading facilities to support the development of new skills in sustainable technologies. The Chief Academic Officer is quoted as saying: “We know that sustainability is a huge issue in engineering, and we know that young people care about it. We’re happy to see professional engineering institutes moving on in their thinking, from environmental impact being a constraint on engineering operations to a guiding framework of innovation which can carry its own opportunities.”

TEDI-London

The TEDI-London philosophy and their Global Design Engineering degree follow the UN’s SDGs and many projects will align with those goals, such as maintaining sustainable cities and communities, good health and wellbeing, affordable and clean energy, climate action, and more.

Department of Chemical Engineering at Brunel University London

In the recently established Department of Chemical Engineering at Brunel University London sustainability forms one of the key pillars running throughout the programme alongside system thinking, bio and safety, problem solving, and innovation.

University of Sheffield

At University of Sheffield all students take part in the Global Engineering Challenge Week which is a compulsory part of the first year programme. The project has been designed to develop students' academic, transferable, and employability skills as well as widen their horizons as global citizens. Working in multidisciplinary groups of five to six for a full week, all students in the faculty choose from several projects arranged under a range of themes including Water, Waste Management, Energy, and Digital with scenarios set in an overseas location facing economic challenge. Some projects are based on the EWBUK's Engineering for People Design Challenge. The EWBUK challenge provides students with the opportunity to learn about design, teamwork, and communication through real, inspiring, sustainable, and cross-cultural development projects identified by EWBUK with its community-based partner organisations. At Swansea University this is within a term-long Engineering for People Hackathon, at the University of Bristol it is within an Engineering by Design first year module while at the University of Glasgow it is contained within the Environmental Engineering first year module.

University College London (UCL)

At UCL over 800 second year students from across the Engineering Faculty take part in a two-week intensive design project experience, How to Change the World. Teams of students are presented with a broad, open-ended societal challenge, ranging from issues such as supplying energy services to rural African locations, to finding solutions to congested transport systems in urban centres. All challenges are focused on real-world topics and are created in partnership with external experts, from policy, industry, and the third sector. In facilitated workshops, students engage with the social, political, and economic dimensions of the problem and use frameworks that enable them to narrow the scope and produce innovative design concepts, while benefiting from feedback and input from external partners. On the final day, students display their work at an Innovation Showcase and pitch their concepts to a panel of experts.

As discussed above there are few undergraduate programmes with a dedicated focus on sustainability:

City, University of London

One notable example is the Energy and Sustainability Engineering BEng/MEng (Hons) from City, University of London. The programme takes a take a multidisciplinary approach to developing the knowledge and skills students need to tackle the challenges faced in sustainable development and access to clean and affordable energy.

The University of Cambridge

The University of Cambridge has quite a clear thread through their Tripos part 1A and part 1B (Years 1 and 2 taken by the majority of engineering students) with a first year module, The Engineer in Society, and second year Sustainable Engineering module.

Manchester Metropolitan University

Manchester Metropolitan University has been involved in the Carbon Literacy Project[18] in its Sustainable Design Module which runs in some of its programmes. The programme promotes an awareness of the carbon dioxide costs and impacts of everyday activities, and the ability and motivation to reduce emissions, on an individual, community, and organisational basis.

Resources for introducing sustainability into the curriculum

The Engineering Professors' Council Sustainability Toolkit, developed in partnership with Siemens and the Royal Academy of Engineering, offers a wealth of resources to support instructors to bring sustainability and sustainability related topics into the classroom.[21]

The Engineering Professors' Council (EPC) is the representative body for engineering academics (at all levels – not just professors) in higher education. We speak out on behalf of all engineering academics and speak in to inform our members on current news, events, policy and data. The EPC also provides a valuable network of support through the Engineering Academics Network to enable engineering colleagues to share expertise and insight. https://epc.ac.uk

Think Up, with support from the Royal Academy of Engineering and the JBM, have identified nine principles for enhancing the way sustainability is taught to undergraduate civil engineers.

It highlights tools, free online resources and suggestions for how to implement these suggestions in the classroom.[19]

The Carbon Literacy Project provide resources and accreditation for those wishing to deliver Carbon Literacy courses.[20]

Engineers without Borders UK. In partnership with the Royal Academy of Engineering, EWBUK has created a Reimagined Degree Map to help educators integrate sustainability as a core part of their engineering degrees.

See: www.raeng.org.uk/engineers-2030

Engineering for People Design Challenge provides students with the opportunity to learn about design, teamwork and communication through real, inspiring, sustainable and cross-cultural development projects identified by EWBUK with its community-based partner organisations.[24]

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Conclusions

This report highlights that while progress has been made on the teaching of sustainability within our engineering programmes and that there is a growing body of examples of good practice, in a large number of cases its prevalence in the curriculum of many disciplines, as evidenced by publicly accessible documents, appears to be low.

It can be seen that a strong emphasis by accrediting bodies, for example the JBM, has a significant impact. We suggest that embedding sustainability in our curriculums and making it visible will not only support our Profession's significant efforts to tackle the Climate Emergency, but it will also appeal to a more diverse population of prospective students who are motivated by careers that will work towards delivering Net Zero targets and are societal and environmentally focussed as well as technical in nature.

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2 Chance, S., Lawlor, R., Direito, I., Mitchell, J.E. (2021) Above and beyond: ethics and responsibility in civil engineering, *Australasian Journal of Engineering Education*, 26:1, 93–116

3 We consider all subjects that are within the Common Aggregation Hierarchy (CAH) codes CAH10-01

4 The survey provided a list of definitions. Sustainability / sustainable development was presented with the following text: “In 1987, the United Nations Brundtland Commission defined sustainability as ‘meeting the needs of the present without compromising the ability of future generations to meet their own needs.’ Sustainable development must meet the challenge of the climate emergency by reducing energy and resource consumption to within the limits set out by science-based targets. Other crucial global challenges that require urgent action include the adverse effects of depletion of resources, environmental pollution, increased consumption, and damage to ecosystems including loss of biodiversity.”

5 JCEETSD, 1997. *Joint conference report, engineering education and training for sustainable development*, Joint UNEP, WFEO, WBCSD, ENPC Conference. Paris. 24–26 September, 1997 as reported in Byrne, E.P., Fitzpatrick, J.J., (2009). Chemical engineering in an unsustainable world; obligations and opportunities. *Educ. Chem. Eng.* 4 (4), 51–67

6 QAA, *Subject Benchmark Statement for Engineering*, Available at: https://www.qaa.ac.uk/the-quality-code/subject-benchmark-statements/subject-benchmark-statement-engineering

7 Joint Board of Moderator, *Guidelines for Developing Degree Programmes*, Available at: https://www.jbm.org.uk/media/hiwfac4x/guidelines-for-developing-degree-programmes_ahep3.pdf

8 L.Gutierrez-Bucheli, G. Kidman, A. Reid, (2022), Sustainability in engineering education: A review of learning outcomes, *Journal of Cleaner Production*, Vol. 330.

9 Byrne, E. P. (2023), The evolving engineer; professional accreditation sustainability criteria and societal imperatives and norms, *Education for Chemical Engineers*, 43, pp. 23–30.

10 Following Byrne, words mentioned in forewords / introductory pieces and any appendix and so on were counted. The professional / master’s or chartered engineering qualification were considered, so mentions in other programmes were not counted, to avoid double counting. Words out of context were not included. It should also be noted that the intended level of detail and length varies between documents.

11 Engineering Council, *Guidance on Sustainability for the Engineering Profession*, Available at: https://www.engc.org.uk/engcdocuments/internet/Website/Guidance%20on%20Sustainability.pdf

12 UCL, *How to Change the World Programme*, Available at: https://www.ucl.ac.uk/centre-for-engineering-education/research-projects/2018/jun/how-change-world

13 University of Sheffield, *Global Engineering Challenge*, Available at: https://www.sheffield.ac.uk/engineering/study/global-engineering-challenge

14 Engineers Without Borders UK’s, *Engineering for People Design Challenge*, Available at: https://www.ewb-uk.org/upskill/design-challenges/engineering-for-people-design-challenge/

15 Desha, Cheryl JK, et al., (2007), *"The importance of sustainability in engineering education: A toolkit of information and teaching material,"* Engineering Training and Learning Conference.

16 M. Thürer, I. Tomašević, M. Stevenson, T. Qu, D. Huisingh, A systematic review of the literature on integrating sustainability into engineering curricula, *Journal of Cleaner Production*, Vol 181, 2018.

17 Engineering Council, *Recognised course search*, Available at: https://www.engc.org.uk/education-skills/course-search/recognised-course-search/

18 Carbon Literacy Project, *MMU Trains World's First CL Engineering Students*, Available at: https://carbonliteracy.com/mmu-trains-worlds-first-cl-engineering-students

19 Expedition Workshed, Available at: https://expeditionworkshed.org/workshed/teaching-sustainability-to-engineers/

20 Carbon Literacy Project, Available at: https://carbonliteracy.com/

21 Engineering Professors’ Council, *Sustainability Toolkit*, Available at: https://epc.ac.uk/sustainability-toolkit/

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