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EDITORIAL

# Education Earth Stewards or Vandals?

*"The truth is that many things on which our future health and prosperity depend are in dire jeopardy: climate stability, the resilience and productivity of natural systems, the beauty of the natural world, and biological diversity. It is worth noting that this is not the work of ignorant people. Rather, it is largely the result of work by people with BAs, BSs, LLBs, MBAs, and PhDs…"* (David Orr, Earth in Mind).

While University Living Labs are not unique to sustainability, those of us leading next generation sustainability for next generation learning unashamedly embrace their promise: applied learning and employability skills for students, problem-solving for campus managers, a rich and real-world learning experience for academics, and a redefined student experience and new levels of student retention and satisfaction for senior managers.

I'm reminded of the words of Marshall Goldsmith: "What got you here, won't get you there". If education is going to be the key to the delivery of the Sustainable Development Goals, something has to change. We have a choice: will our universities produce earth stewards or earth vandals?

Living Labs provide an opportunity for students to leave our universities better able to understand and grapple complex issues that cross several disciplines, to develop crucial professional skills necessary for work, and the ability to critically address moral and ethical dilemmas. A Living Lab challenges out-dated disciplinary silos which drive inefficiency and squander innovation, with too many graduates entering a world with irrelevant knowledge and training that has been delivered in environments far removed from reality.

Despite the diversity and resourcefulness of university stakeholders, universities and colleges are under significant pressures from multiple ends, internally and externally. Large portions of each stakeholder group are both searching for the solution in isolation and trying to solve parts of the problem that only affect them.

There is a need for a common set of values and collective action that recognises the overall shared challenge. I believe that Living Labs have potential to contribute to a post-16 education sector sustainability revolution. It is much needed.

In order to help drive this revolution, ably led by Hassan Waheed, the Environmental Association for Universities and Colleges (EAUC) conducted a research project on Living Labs in the higher education sector which you can read about in Hassan's article. If we are to be stewards of people and planet, the education that got us here, won't get us there. We celebrate and thank IES for dedicating this edition to the transformational agenda which is Living Labs and hope you will seek opportunities for the co-creation of sustainability solutions that the Living Labs agenda facilitates.

**Iain Patton** is Chief Executive at the Environmental Association for Universities and Colleges (EAUC). Established in 1996, the EAUC exists to lead and empower the post-16 education sector to make sustainability 'just good business'. Iain became the first dedicated Environmental (and subsequently Sustainability) Officer in a UK college in 1995. He went on to become the EAUC's first Chief Executive in 2005.

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INTRODUCTION

# What is a Living Lab?

**Hassan Waheed** introduces the concept of Living Labs and how they can be used to create inventive and society transforming research projects.

Living Labs were popularised in a recent wave of endeavours to find the most impactful way of conducting innovative education and research that overcomes major internal and external barriers[1]. In order to help drive this revolution, the Environmental Association for Universities and Colleges (EAUC) led a research project on Living Labs in the Higher Education sector[2], which this introduction draws from. "A Living Lab is where real-world sustainability challenges are formally addressed in stakeholder partnerships"[3]. In essence, a Living Lab programme aims to potentiate the bond between people of different backgrounds so they may collaborate for mutual benefit. Firstly, it accounts for all the different stakeholders who could be more closely involved with a university's education and research practices, which includes professional university staff and various types of external stakeholders. Thereafter, a Living Lab takes into account the main barriers in the way of: 1) academics; 2) students; 3) professional staff; and 4) external stakeholders.

In practice, this allows individuals and teams from the four stakeholder groups to find opportunities of mutual benefit and initiate real-world sustainability projects around them.

### WHAT DOES A LIVING LAB PROGRAMME INCLUDE?

The objective of a Living Lab programme is to establish a platform where people from different stakeholder groups can easily and effectively collaborate (**Table 1**). For most Living Lab projects, academic stakeholders (academics and students) collaborate with practitioner stakeholders (professional staff and external stakeholders) in various combinations. Academic stakeholders provide intellectual capacity and support for solving sustainability problems, while practitioners provide expertise, access, and space that allows students and researchers to put theory into practice. All stakeholders benefit in their own areas while contributing to other stakeholders' priorities, as well as making the university or local area more socio-economically and environmentally sustainable. By serving as a tool for aligning agendas, a Living Lab can become a very powerful mechanism for top-down as well as bottom-up change. It is useful for individual academics and departments who wish to find feasible ways of conducting innovative education and research. It is equally useful for university operational managers or education and research decision-makers looking for resource efficient and cost-effective ways to transform institutional practices (i.e. using the institution's own latent potential to solve its problems).

### LIVING LABS: A SPARK FOR THE NEXT GENERATION

Living Labs are important for all universities[4]. They enable substantially more transformative education and research activities because they account for and help overcome internal and external barriers. Living Labs can also help build capacity for all stakeholder groups by connecting them through a common cause. This can help build the capacity of institutions in dealing with major barriers, which in turn helps enable radical education and research potentialities of universities. In doing so, Living Labs can ultimately become a spark for larger internal and external transformations. ES

▼ **Table 1. Benefits of a Living Lab for the four major university stakeholder groups.**

| Stakeholder groups | Key challenges faced by stakeholder groups | Benefits of a Living Lab programme |
|---|---|---|
| **Students** | Content-driven, theory-focussed and detached education that is not effective in training students for the real-world. | Provides real-word sustainability projects as part of formal curricular and extracurricular activities. Creates opportunities to work and train with stakeholders using real-life problems that graduates will face. |
| **Academics** | Attracting funding to conduct leading and impactful research to be published in quality journals. | Real-world impact through participation in sustainability projects. Provides an opportunity to innovate, test and prototype solutions to produce cutting-edge research. Creates transdisciplinary research which could offer more innovative outcomes. |
| **Professional staff** | Finding cost savings, increasing business operation efficiency and improving the corporate reputation of the university. | Provides extra capacity and intellectual support to solve major issues. Cost effective technique. Provides a project which could improve sustainability. |
| **External stakeholders** | Any number of social, economic and environmental issues faced by various different individuals, non-governmental organisations, communities, organisations, businesses etc. | The conduct of hands-on support and systematic research to solve crucial problems. Creates partnerships and links with institutions. Has the potential to address common problems. |

**Hassan Waheed** worked with the EAUC as a researcher and project developer. He led the development of the EAUC Living Labs Project and authored multiple publications on the concept. Prior to that he also co-developed the Sustainability Mapping project, and more recently also co-led the foundational work for the international SDG Accord for universities and colleges. Hassan now works for Soil Association Scotland as a researcher on the Food for Life programme.



INTRODUCTION

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CASE STUDY



# Universities as Living Labs for sustainable development: A global perspective

**Walter Leal Filho, Baltazar Andrade Guerra, Mark Mifsud** and **Rudi Pretorius** use case studies from Brazil, Malta and South Africa to reflect on how the Living Labs approach can contribute towards a more sustainable future.

Living Labs are conventionally not necessarily associated with universities. However, with the increasing pressure on universities to conduct research that has relevance to society, to assess regional development needs and beyond, and to address real-world sustainability issues, universities have a huge potential contribution to make in this regard. They frequently not only initiate innovation, but also work in terms of the longer time horizons required of sustainable development initiatives[1]. The three case studies dealt with in this article present different approaches to university-initiated Living Labs for sustainable development from across the world, each illustrative of a different type of innovation, in a dissimilar context, with diverse actors, and with a variety of impacts and challenges.

## THE CASE OF THE FIRST SOLAR SCHOOL IN BRAZIL

The University of Southern Santa Catarina (Unisul) was founded in 1964 in the city of Tubarão in Southern Brazil. Today, Unisul is one of the largest universities of the state, with nearly 30,000 students, and it develops and implements many strategies to achieve local sustainable development through research, teaching and outreach. One example of a Unisul programme is 'Promoting Renewable Electricity Generation in South America' (REGSA), an international collaborative project in which Unisul was the Brazilian partner. Stated as "Contributing to increase the use of electrical energy obtained by means of renewable energy generation in South America as a way to improve the environmental conditions, enhance the energy security, and alleviate the poverty of the project areas", it was a partnership between the Hamburg University of Applied Sciences, the Catholic University of Bolivia, the University of Chile and Unisul, and funded by the European Union[2]. Unisul was tasked to develop a pilot project to promote renewable electricity generation in Brazil, serving as a model of good practice.

A primary school in a Brazilian rural community was chosen by Unisul to create the first 'solar school' in Brazil. They did this by looking at generating solar energy, improving their energy efficiency, luminous and thermal comfort, and promoting awareness on renewable energy and sustainability. This project transformed the school into a Living Lab for sustainable knowledge development for both Unisul academics (the students and professors of the school) and the local community (**Figures 1 and 2**). The school currently has 20 collaborators and nearly 200 students with ages ranging from 4 to 15 years old[3].

▲ **Figure 1. View of Roberto Schütz School, showing the grid of solar panels used for electricity generation (© Wellyngton S de Amorim).**


▲ **Figure 2. Cultural festivities at the Roberto Schütz School form part of the sustainability triad consisting of the physical, economic and sociocultural environment (© Wellyngton S de Amorim).**

To improve energy efficiency and luminal comfort in the school, Unisul made aesthetic reforms in the classrooms and in the library, replacing 48 lights, 192 lamps, and painting the walls and ceiling; this was also found to help with improving students' performance and concentration. Additionally, a solar water heating system was installed to provide occupants with warm water in the kitchen and bathrooms. The installation of 27 photovoltaic panels supplied the school's energy needs and any surplus is shared on the grid[4]. A garden and an orchard were also developed so students could grow their own food and develop better eating habits.

The REGSA team, led by Unisul, also gave several lectures and workshops to the students and the community on photovoltaic panels, energy efficiency, and sustainable technologies. The school, supported by Unisul, also promoted several programmes, lectures and workshops that discussed the challenges of sustainability, the limitation of natural resources and the need to promote environmental conservation (**Figure 3**).

Additionally, the engagement of many stakeholders (i.e. members of the local community, the university's academic staff and the students in the school) allowed them to experiment with real-life practices linked to renewable and sustainable technologies, and education for sustainable development.

## THE UNIVERSITY OF MALTA: A NEW DEGREE

The Centre for Environmental Education Research (CEER) at the University of Malta was initiated in 2004 with the intention of functioning as a centre of excellence for environmental education research in the Mediterranean. CEER seeks to stimulate change towards a sustainable society through provision of opportunities for environmental education that may empower citizens, irrespective of their age, gender or socio-economic status, to actively participate in forums for environmental decision making, and to take part in initiatives aimed at the promotion of a good quality of life. The Centre recently launched its first Masters in Education for Sustainable Development (MESD). This is a three-year course that targets teachers and education experts, and aims to provide different perspectives on sustainable development, contextualised with reference to the interaction of environmental, societal and economic concerns[5].

The MESD aims to present students with different perspectives of: i) the environment; ii) environmental education and education for sustainable development; iii) the interaction between the environment and society; and iv) sustainable development. The course is structured through a philosophy that will enable students to study issues relating to education in sustainable development in the context of different environmental realities, and to experience different environmental, social, cultural, political






▲ **Figure 3. Projects on renewable energy by students at the Roberto Schütz School (© Wellyngton S de Amorim).**

and educational perspectives. Additionally, students are able to access and critically evaluate research on education for sustainable development and to develop the skills and attitudes necessary to promote sustainable lifestyles.

As part of the MESD, students are required to work on realistic practical projects with real end users in mind. Therefore, their studies have direct relevance to improving local people's lives. This includes reference to the concepts of nutrition and sustainability, sustainable transport, waste and recycling, engaging locals in sustainability and creating more effective teaching and learning frameworks. The focus is mainly on the local scenario, but the results and methodology will also be useful in the wider context.

The first cohort of students for the course contributed extensively to the evolution of the MESD. As the taught component was nearing its end, several discussions on how the course should be improved for its second intake were conducted. Through the analysis of a number of suggestions thus obtained, some potential improvements emerged. The most relevant to Living Labs included suggestions on the facilitation of interdisciplinary work, and the exchange of expertise on sustainable development both within the course and in the local community. Outreach to other communities, nationally and internationally, and the production of educational materials were also cited. The Living Labs methodology was successfully utilised in the MESD because it provides a range of applied learning opportunities, linking students to the wider community and facilitating behavioural change.

## UNIVERSITY OF SOUTH AFRICA: OPEN & DISTANCE LEARNING

Engaging students in real-world situations and to get in touch with sustainability issues, has a unique meaning in open and distance learning (ODL). Since these students are typically not on campus, teaching and learning takes place in the living or working contexts in which they find themselves. This creates a unique application of the Living Labs approach. The University of South Africa (Unisa) is well known and focuses exclusively on ODL, ranging from short courses and certificate programmes to three to four year degrees and up to doctorates. Unisa currently offers study opportunities to more than 400,000 students, mostly from South Africa, but also other African countries and the rest of the world.

The vision of 'The African university shaping futures in the service of humanity' drives Unisa to make authentic contributions to society, and to nurture a critical citizenry to ensure sustainability[6].

▲ **Figure 4. Workshop on community asset mapping conducted by staff members of the Department of Geography in Koffiekraal/Brakkuil, South Africa (© Rudi Pretorius).**

**"Students, academic staff, researchers, estates or facility staff and external stakeholders are brought together in a collaborative framework to contribute to real-world sustainability knowledge."**

At Unisa, the Living Labs approach features prominently in terms of the focus areas of teaching and learning, research and community engagement, through which students, academic staff, researchers, estates or facility staff and external stakeholders are brought together in a collaborative framework to contribute to real-world sustainability knowledge. Taking some of the undergraduate study programmes in the School of Ecological and Human Sustainability (SEHS) at Unisa as examples, the transformation towards e-learning and the development of the associated information and communication technology infrastructure play an important role to facilitate collaborative learning between students and also between students and lecturing staff. This type of interaction encourages students to reflect not only on their own frames of reference, but also to learn about the viewpoints of others.

Furthermore, through inquiry-based and work-integrated learning, students can apply their insights to various local and employment contexts[7,8]. This empowerment to make a contribution to deal with environmental issues at local level addresses an identified need in the African context. Undergraduate study programmes offered in the SEHS relate to environmental management, nature conservation and horticulture. These programmes utilise a blended approach to teaching and learning, which is unique due to the variety of ways through which ODL, practical sessions and work-integrated learning are combined to provide students with rich environments for active learning. At junior postgraduate level, this is taken a step further with the facilitation of student-driven research projects in the context of real-world problem scenarios.





Connected to and following on from the preparatory work at undergraduate level, research projects at Masters and Doctoral level in the SEHS extend the Living Labs approach to various real-world sustainability-related innovations. This includes partnerships between academia and stakeholders in business, government and the citizenry at large. An example is the interdisciplinary and transdisciplinary research on climate change adaptation and mitigation in the Department of Environmental Sciences. Another example is the Applied Behavioural Ecological and Ecosystem Research Unit, with focus on acquiring insight into indigenous wildlife, vegetation and water in natural and urban environments, and the monitoring of different managerial interventions. The experience thus obtained is applied to develop models which support recommendations to improve management and understanding of ecosystems to ensure sustainability and biodiversity protection.

The facilitation of community asset mapping programmes with rural communities in South Africa by the Department of Geography provides an example of Living Labs in action[9] (**Figure 4**). These programmes aim to empower communities through adult learning to create sustainable self-employment opportunities that assist them to drive their own development and are conducted hands-on in various local contexts. The outcome of a programme that was conducted in 2012 in Koffiekraal and Brakkuil (two small villages in rural South Africa) was that community members expressed their desire to form a community-based tourism group. Through a tailor-made learning strategy (**Figure 5**), staff members of the Department of Geography subsequently guided the participating community members to the stage where they could develop and take ownership of a community-driven village tour, with potential benefits in terms of sustainable livelihoods and poverty alleviation (**Figure 6**).

▲ **Figure 5. Mind map of community assets and potential resources for tourism by community members of Koffiekraal/Brakkuil (© Rudi Pretorius).**

The few examples from the SEHS mentioned here illustrate how teaching and learning, research and community engagement activities at Unisa, add value to and promote the principles of the United Nations Global Compact (UNGC). Unisa became a signatory to the UNGC in 2007 and adopted an Environmental Sustainability Policy in 2012. This was followed in 2013 by the Green Economy and Sustainability Engagement Model as well as the establishment of a Sustainability Office. The various academic activities in the SEHS are therefore increasingly supported by an institutional governance model geared towards sustainability. In this way, the utilisation of the Unisa infrastructure in support of the Living Labs approach is in a growth phase, and is set to experience some exciting developments in the near future.

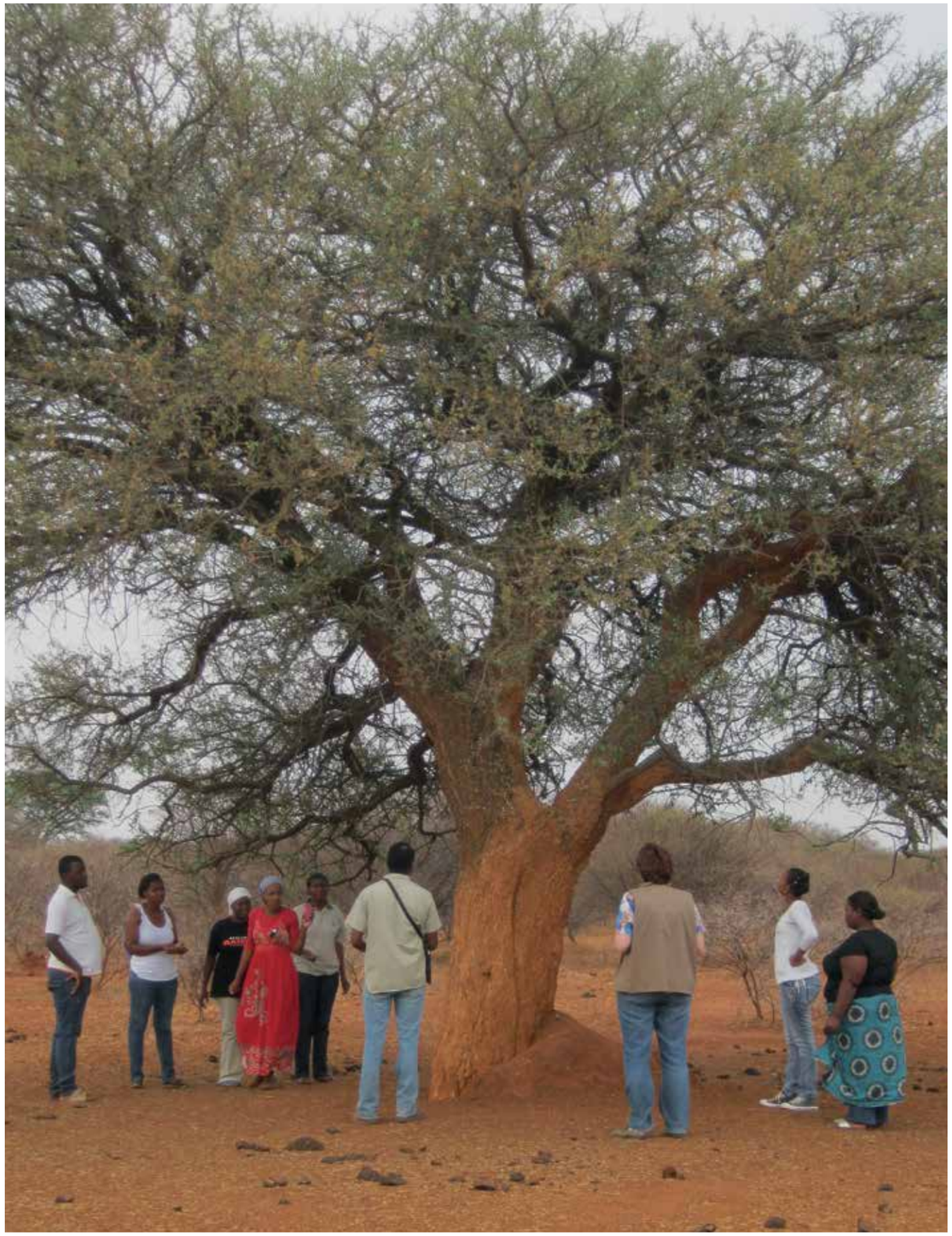
## COMMONALITIES AND DIFFERENCES

The three case studies presented in this article illustrate the diversity of means to realise the Living Labs approach. It is an increasingly popular strategy for universities to use in order to address sustainability challenges through the facilitation of hands-on type learning experiences for students, whilst merging academic activities with campus management and operations. Institutions are not only providing students with real-world skills, but are also providing themselves with a path to meet expectations in terms of sustainability goals. The initiatives reported on in this paper illustrate that to achieve success with Living Labs, research, technological innovation, and social and cultural aspects need to be skillfully integrated over long time horizons, therefore making it possible for the associated innovation processes to eventually bear the desired outputs. This corresponds with and supports the observations by the researcher Von Geibler[10].

Despite apparent successes, the three cases presented are illustrative of the challenges to be expected with the implementation of Living Labs[10], and include the following:

- Difficulties associated with inter and transdisciplinary collaboration.
- Scepticism about viability by various role players.
- Lack of funding and/or limitations due to principles applied by funding bodies.
- Low visibility of Living Labs and the potential associated with them.
- The long time horizons involved which put a strain on long-term viability.

Similar to other research findings on Living Labs[11], the cases dealt with in this article, especially for Malta and South Africa, highlight a key strength of the Living Labs approach; namely that it provides a framework to facilitate specifically not only student engagement but also academic involvement with sustainability issues in a systematic way. This is a particularly important point for many universities, especially to balance the challenges



▲ **Figure 6. A visit to a historic tree forms part of the village tour designed by the community interest group in Koffiekraal/Brakkuil (© Rudi Pretorius).**





associated with increasing enrolments, decreasing budgets, and ageing infrastructure. In this situation, Living Labs can facilitate experiential learning, reduce the carbon footprint, and use institutional resources efficiently[12]. Thus Living Labs offer a framework to connect students to applied research, synthesise teaching, and bring social responsibility to realise universities' potential to address sustainability challenges[11].

Although the varied nature of and linkage to local contests of Living Labs for sustainable development are clear, their flexibility, simplicity and adaptability cannot be disputed. Despite these advantages, their implementation and execution by universities require careful, integrated planning. They should not be regarded as a panacea to deal with all sustainability issues in all contexts, i.e. they have limitations. An accessible platform is therefore required to be continuously updated and through which experiences can be shared and disseminated. This will feed a vibrant research agenda with results feeding back to current as well as future projects in a continuous improvement cycle. ES

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# Student Capital: Broadening the appeal of sustainability engagement

**William Clayton, James Longhurst, Chris Willmore** and **Georgina Gough** demonstrate how a symbiotic relationship between universities and local authorities can nurture a sustainable future for all.

FEATURE

The biggest sustainability impact of any university is its graduates, who typically will have 60 years of life (and planetary impact) post-graduation[1]. Across the world, universities have direct access to millions of bright and capable young people, many of whom are experiencing a significant transitional stage in their lives, making their years in Higher Education a perfect opportunity to establish a long-lasting understanding of, and engagement with, key issues of sustainability. After all, these students will be amongst those directly responsible for building a more sustainable future in the decades ahead.

© Green Capital: Student Capital project

As a response to this, the Student Capital project was initiated in Bristol in 2015 with the main objective of increasing student sustainability engagement, and importantly, of increasing its mass appeal.

## GREEN CAPITAL: STUDENT CAPITAL

Bristol has a university student population of approximately 50,000 – comprising some 10 per cent of the population of the entire city. This offers the potential to have a substantial, practical ongoing impact on sustainability in the city-region. Both of the city's universities – the University of Bristol, and the University of the West of England – have well established sustainability volunteering and 'Education for Sustainable Development' programmes, but until recently, much of their work has been looking inward, focusing upon campus sustainability. Reflecting upon this, the universities were keen to challenge themselves to engage more students, and moreover to increase the wider experience and impact of students already engaged.

In 2015, Bristol was conferred the status of 'European Green Capital'. This was initiated partly for the city's efforts in tackling some of the difficult sustainability issues it faces, but also for its vision of becoming an inclusive, sustainable city by the middle of the 21st century, with goals to become happier, more prosperous, and fossil fuel free by 2065. Both universities were directly involved in the planning of Bristol's 'Green Capital Year', and sparked an idea of being a timely and useful opportunity to experiment in methods of increasing student sustainability engagement.

Using the Green Capital Year and its associated publicity as a catalyst, the universities and their respective Student Unions entered into a unique partnership, working across the entire city with hundreds of local organisations. With project funding from the Higher Education Funding Council for England, the Green Capital: Student Capital project (commonly known as the Student Capital project, summarised in **Box 1**) took, as a starting point, the requirement to support students to develop their personal understanding of sustainability through opportunities that mobilised the creativity of students to transform the city. Its focus was on sustainability in the city and outside of the campuses, with the following aims:

i. To contribute to Bristol's citywide European Green Capital status by creating a sustainable inclusive city through the mobilisation of the student community in that mission.

ii. To support students to develop skills as agents for sustainability action through engagement in the transformation of their city.

The project also aimed to be sustainable, ensuring that the student engagement in sustainable issues continues into the future, and that the new systems or platforms which were created can continue to support this. The project took the whole city as its 'Living Lab' – a broad canvas enabling a rich and varied experience.

**"The students that engage in these Living Labs have an opportunity to be involved with real-life challenges and experiment with creative solutions – helping the universities and partner organisations to have a positive impact across the city and beyond."**

### BOX 1: GREEN CAPITAL: STUDENT CAPITAL PROJECT

To generate a sense of ambition and excitement, the Student Capital project set a number of high profile public targets. The project committed to:

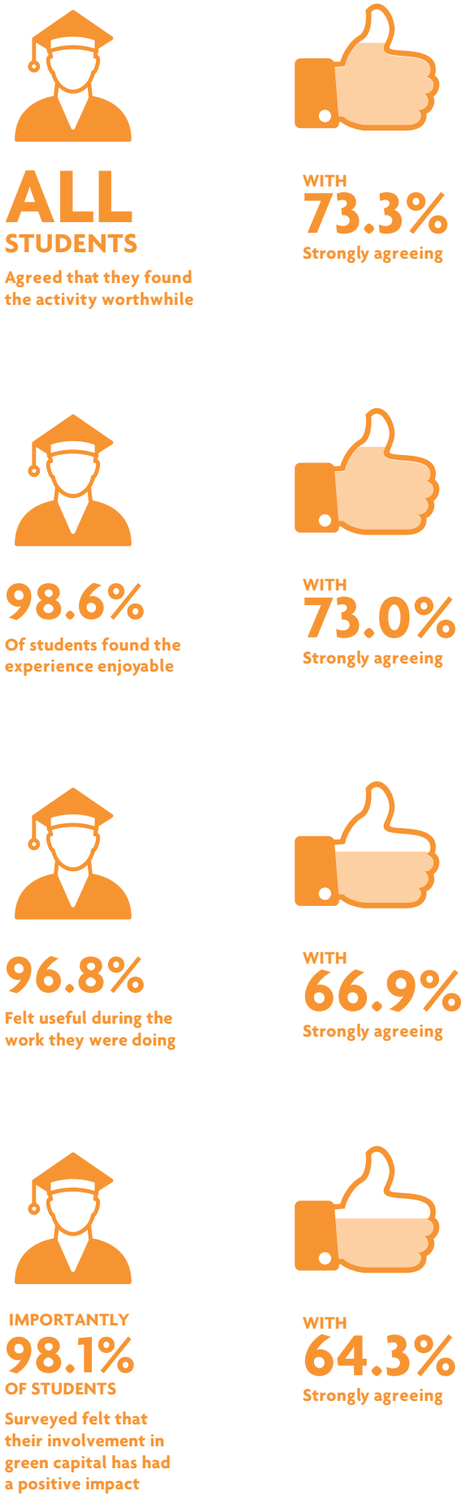
- Supporting 100,000 hours of student sustainability engagement in the city (with a minimum of 600 students involved).
- Building a network of over 200 local organisations to provide sustainability engagement opportunities to the students.
- Achieving high levels of satisfaction amongst both students and organisations.

The team worked to create opportunities across the full range of the universities' activities, including both curricular and extra-curricular engagement[3]. This included:

i. Volunteering – working closely with the volunteering teams and Student Unions at each university for maximum reach and to take advantage of pre-existing systems and networks.

ii. Placements and internships – working with the relevant teams at each university and finding suitable courses with a sustainability aspect that would provide opportunities for engagement. Additionally, a set of Green Capital internships were created especially for 2015.

iii. Projects – working with academic staff it was possible to use the Green Capital Year as a focal point for student projects on modules relating to sustainability. This was great for both students and staff, and created a very involved learning experience with strong relevance to both local and global issues.




▶ **Figure 1. Results of the survey conducted on students involved in the Green Capital Project**

▼ **Table 1. Demographic data for participating students.**

| | | Student capital (%) | All participating students (%) | Difference (%) |
|---|---|---|---|---|
| **Gender** | **Female** | 65.5 | 55.0 | 19.1 |
| | **Male** | 34.5 | 45.0 | -23.3 |
| **Age** | **18-21** | 53.4 | 50.9 | 4.9 |
| | **22-25** | 35.4 | 23.4 | 51.3 |
| | **26-29** | 6.9 | 9.3 | -25.8 |
| | **30+** | 4.3 | 16.4 | -73.8 |
| **Residency** | **UK** | 61.0 | 86.1 | -29.2 |
| | **EU** | 11.9 | 3.3 | 260.6 |
| | **International** | 27.1 | 10.6 | 155.7 |
| **Course Type** | **Full-time** | 93.4 | 83.7 | 11.6 |
| | **Part-time** | 6.6 | 16.3 | -59.5 |

## BOX 2: MARKETING STUDENT EXPERIENCE

"There are so many amazing, cool green projects and initiatives popping up all over the place. So much to get involved with, whether to give back to the community or just promote a little 'green' in your everyday life. Bristol is buzzing with sustainable activity!"

© Green Capital: Student Capital project

### CREATING OPPORTUNITIES FOR ENGAGEMENT

The approach of the city as a Living Lab with participation from local institutions and organisations has centred on supporting students and their experiences, but also changing the Living Lab space. It has fostered an environment in which ideas are formed and developed, and opportunities for ongoing collaboration nurtured. The students that engage in these Living Labs have an opportunity to be involved with real-life challenges and experiment with creative solutions – helping the universities and partner organisations to have a positive impact across the city and beyond.

The Student Capital project adopted a very inclusive approach to the kinds of activities and opportunities that would fall within in its scope in order to enable students to see how the 17 Sustainable Development Goals (SDGs)[2] are interconnected. The project definition of 'sustainability' includes a whole spectrum of issues and challenges relating to human impacts across all the SDGs (present and future).

In adopting this broad interpretation of sustainability, the project has sufficient freedom to include the varied interests of students on the full range of different courses, and has enabled students to experiment across activities to discover their own voice, making this a Living Lab for self-discovery.

### THE CHANGE MAKER AWARD

The Green Capital Change Maker Award was created to provide a tangible accolade to mark students' accomplishments, and to create a sense of pride and recognition in the city. These awards are now established, meaning that each year more students will have the opportunity to become 'Change Makers' and their achievements recognised by city leaders in a public award ceremony. This is one of the significant legacy impacts of the Student Capital project.

So far, the ceremonies have seen hundreds of students recognised for their efforts, with projects that include:

- Delivering lessons on sustainability in primary schools.
- Campaigning to reduce consumption of plastic bags and single-use plastic items.
- Raising awareness of homelessness by getting groups of students to knit items for donation.
- Helping non-governmental organisations to develop new business plans.
- Campaigning for divestment from fossil fuels.

### WHAT HAS BEEN ACHIEVED?

The aim to broaden engagement was successful. The Student Capital project engaged with over 7,500 students, who contributed 127,000 hours of their time – equal to more than 74 years' work.

The project collected data on the students that took part, which provided detailed statistics and qualitative feedback. The majority of students found the experience positive (**Figure 1**).

The demographic data allowed an examination of the characteristics of the different students that took part (shown in **Table 1**). The demographic data has been compared to the demographic statistics for the wider university population, thus demonstrating the ways in which the Student Capital project has proven particularly attractive to different groups of students.

## BOX 3: FEEDBACK FROM LOCAL ORGANISATIONS

Dominic Driver, Chair of the Sims Hill Community Woodland group, was enthused with the work from those on the Student Capital project.

"Students have been really valuable. We got them involved last year and they added a vibrancy to what we're doing in the woodland. The problem was stopping them, not starting them; they worked so hard and they were great."

Growing Support were equally impressed with the students' levels of engagement. Ruth Baker, a volunteer involved in managing students' activities said:

"Having students involved in our project has been great because they bring a real diversity to what we do. We work with older people and so having younger volunteers is just fantastic for everybody involved."


© Green Capital: Student Capital project

### BOX 4: CREATIVE PRODUCT DESIGN STUDENT

"My most meaningful and enjoyable thing about this whole experience was going into the school to do the first workshop, even though nervous, the children gave a great response and it was fun being able to give the children an hour of my day. Also, seeing how intelligent some of the children were about climate change and sustainability issues was also very surprising, and seeing how much they wanted and were willing to help was amazing."

© Green Capital: Student Capital project

Given the breadth of the project, which was designed to offer opportunities for all, it was of interest to see which students engaged the most. The data show that female students were more likely to engage than male students. A markedly higher proportion of students in the age range 22 to 25 participated in the project than the average, suggesting that it was particularly attractive to this demographic. However, the most significant impacts were in relation to international students; 39 per cent of students engaged were not from the UK. In qualitative feedback gathered from participants, there were suggestions that engagement in Living Labs of this kind was seen as particularly beneficial to these students – offering a chance to explore and understand the city (and country), to develop a sense of belonging, and to engage and develop relationships.

Students and local organisations also provided qualitative feedback on their experiences of the Student Capital project, which helped to explain the value of engagement. A selection of these are presented in **Boxes 2-6.**

**"Higher education institutions must seek to create partnerships with a large network of external organisations, and to engage as much of the student community as possible."**

## LESSONS LEARNT FOR THE FUTURE

The Student Capital project has broadened the appeal of sustainability engagement to groups of students that might not have previously been engaged, and offered outward facing opportunities to participate in a city wide Living Lab. However, the project was not without its challenges.

An important part of the legacy of the project is to share the knowledge and experiences gained to other cities and institutions who are also interested in mobilising the student community for sustainability action. A number of important messages from the project have been distilled from the experience, and offer guidance to future projects of this type.

## THINK BIG, WORK TOGETHER, TAKE RISKS

Living Labs work, and the Student Capital project was successful in mobilising people. But projects of this type work best when we 'think big'. Large Living Labs make both the work and its impacts highly visible. This visibility acts as promotion for the aims of the project, can encourage more people to be involved, and further strengthen the project.

### BOX 5: BUSINESS AND MANAGEMENT STUDENT

"The most enjoyable thing about this experience was helping young children get interactive within the community. Seeing children get excited about this game made it all worthwhile. Being able to help the younger generation understand the impact they have on the planet and those wanting to actively change this, made the experience for me extremely meaningful. It gave me hope for the future."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### BOX 6: SCHOOLS PLUS PROJECT

One teacher working in the Schools Plus Project highlighted the importance of the Student Capital project in linking the community with the local university.

"The whole experience has been brilliant, and left the group feeling really positive. It has been a two way process and we have shared information and had input all the way through. It has been fantastic to work with the university. Lots of people in this area don't go to university or have any connections. We were pleased to establish links to a previously untapped pool of knowledge and expertise."


© Green Capital: Student Capital project

Teamwork is paramount. So much more can be achieved collectively than in isolation and working across the whole university and between universities is important. Higher education institutions (HEIs) must seek to create partnerships with a large network of external organisations, and to engage as much of the student community as possible. Local councils and authorities can then see HEIs as a valuable partner in delivering change for sustainability.

Some things will work and some things will not. The overall success of the project should be measured at the higher levels, not by the occasional missed opportunity or unsuccessful approach. Students should be encouraged to experiment with the engagement opportunities they create for themselves.

## FUNDING, VISIBILITY AND FEEDBACK

Having sufficient support for a student engagement project is critical. Universities have a central role to play in facilitating, promoting, and maintaining engagement through the opportunities they creates via their links to external organisations, and in supporting students that they are engaging with. Providing such support in an effective ongoing way requires staff time and resources.

Opportunities, action and benefits must be visible. Both inside the HEI and outside the city, sustainability engagement should be given a high profile.

Through adopting a rigorous external evaluation process, the project has benefitted from accurate and useful feedback which has highlighted both the successful and more challenging aspects of the project. ES

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CASE STUDY

# Living Labs in the context of sustainable development

**Konstantinos Tzoulas** and **Stuart Marsden** describe how using the Living Lab approach has helped develop an accredited environmental management system for Manchester Metropolitan University.

Biodiversity conservation is a key component of sustainable development. However, environmental management systems (EMS) of universities often do not prioritise biodiversity policy[1]. In 2015, Manchester Metropolitan University (Manchester Met) was accredited with meeting ISO14001:2015, the International Standard for Environmental Management. Biodiversity and learning as distinct policies, and a participatory approach, were key innovations of the university's EMS[2].

The university's EMS comprises 12 policies, each with its own aim, targets, indicators and projects; three environmental sustainability public reports; four underpinning management systems; and reporting and feedback processes (**Figure 1**). The environmental sustainability public reports comprise: policy – collected broad aims and objectives for each policy; strategy – collated specific measurable targets and key performance indicators for each policy; and an action plan – a collation of specific projects delivered and related timescales for each policy. The management system's overarching goal is mitigating environmental impacts, ensuring legal compliance, improving operational procedures, and identifying the leader and delivery teams for each policy. The leaders of each policy form the Environmental Management Group, which corresponds with senior managers in a two-way communication process.

The aim of the EMS's biodiversity policy is to "Protect and enhance biodiversity across the university's green infrastructure and promote its benefits for students, staff, visitors and the local communities"[3]. To support the delivery of the biodiversity policy aim, a new service of ecological surveys on campus needed developing. The concept of 'Living Labs' was adopted as a means to do this, and it was called the 'Bio-campus Project'.

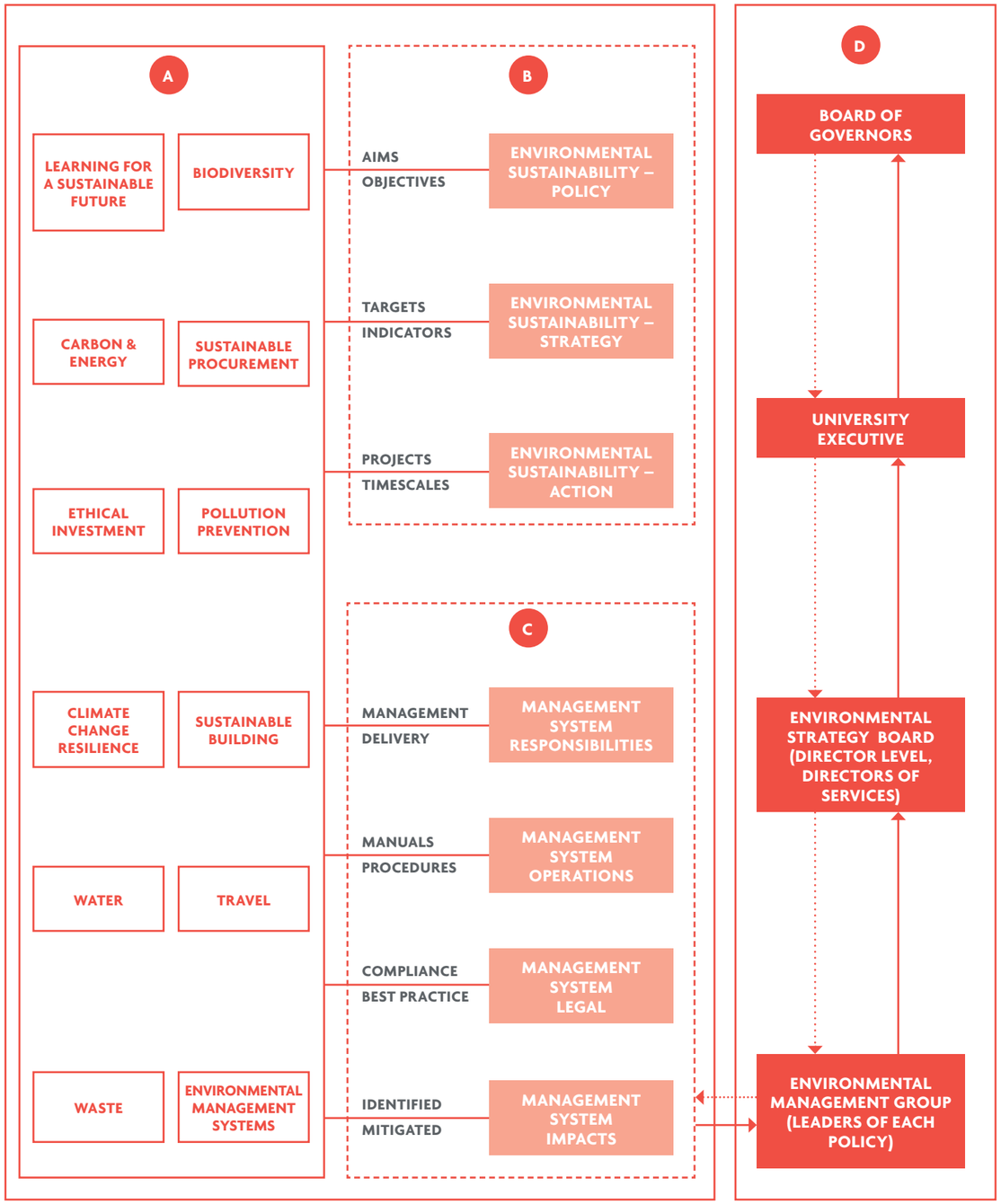
The aim of this project was to develop a service of ecological surveys to support the delivery of the biodiversity management system and to inform the university's capital and grounds maintenance plans. The objective of the project was to establish, undertake and maintain annual ecological monitoring, including related data storage and reporting systems, for plants and animals across the university's campus.

The innovation behind the Bio-campus Project is the bringing together of academic staff, students, non-academic staff, the private sector, and the local community in developing a new service that directly supports the delivery of one policy within the university's EMS.

## OVERVIEW OF THE BIO-CAMPUS PROJECT

The Manchester Met campus is located in the north west of England, and comprises four sites in the city of Manchester and one site in the borough of Cheshire east (**Figure 2**). Ryebank Fields in Manchester is a brownfield site with natural succession of grasses, shrubs and trees. The Cheshire site includes a stream and a fenced woodland. These areas present particular ecological interest because they have been relatively undisturbed. Other habitat types on campus include managed urban parks, amenity grasslands, community orchards, small wetlands, and five green roofs (**Figure 2**). The remainder of the campus is mainly built and paved areas.

The Bio-campus Project involved establishing, undertaking and maintaining a series of annual ecological surveys for six groups of plants and animals: woody plants, herbaceous plants, lichens, birds, invertebrates, and mammals. Furthermore, the project involved establishing related data storage and reporting mechanisms for the needs of the biodiversity management system.




▲ **Figure 1. Manchester Metropolitan University's environmental management system comprises of: A) 12 policies; B) three environmental sustainability public reports; C) four underpinning management systems; and D) reporting (solid arrows) and feedback (dotted arrows) processes between the leaders of each policy (the Environmental Management Group), senior management (the Environmental Strategy Board) and the University Executive.**





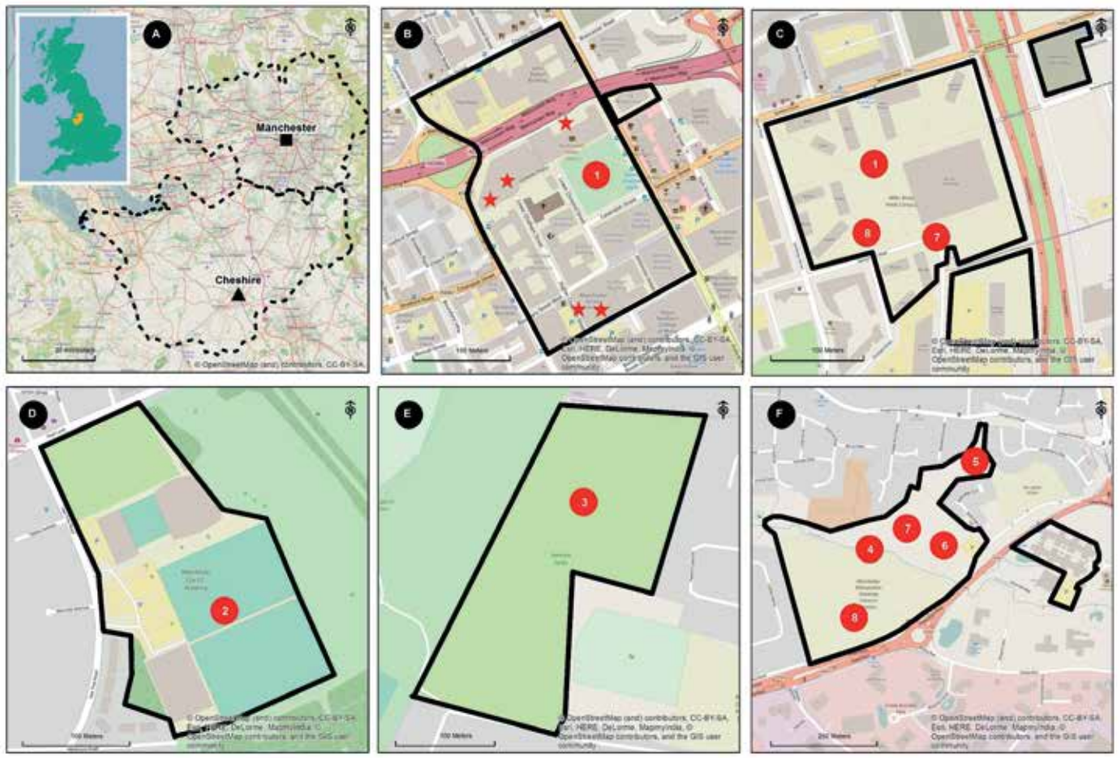
The project has been running for three years. In 2015 the Bio-campus Project surveys were organised as reconnaissance expeditions and convenience sampling was employed along exploratory walks. In 2016, monitoring plots, ecological methods, data storage, and reporting mechanisms were standardised, and the surveys were repeated in 2017. The ecological surveys took place over a period of three days in the first two weeks of June. At each sampling plot, all targeted groups of plants and animals were surveyed on the same day.

Over the course of the three years, 46 individuals have been involved in Bio-campus Project surveys, across academic and estate staff, students, local groups and businesses. The university's Estates Directorate provides funding, organisational, promotional and management support. Academic and support staff from the School of Science and the Environment provided overall research oversight of, and education and training in, ecological surveys.

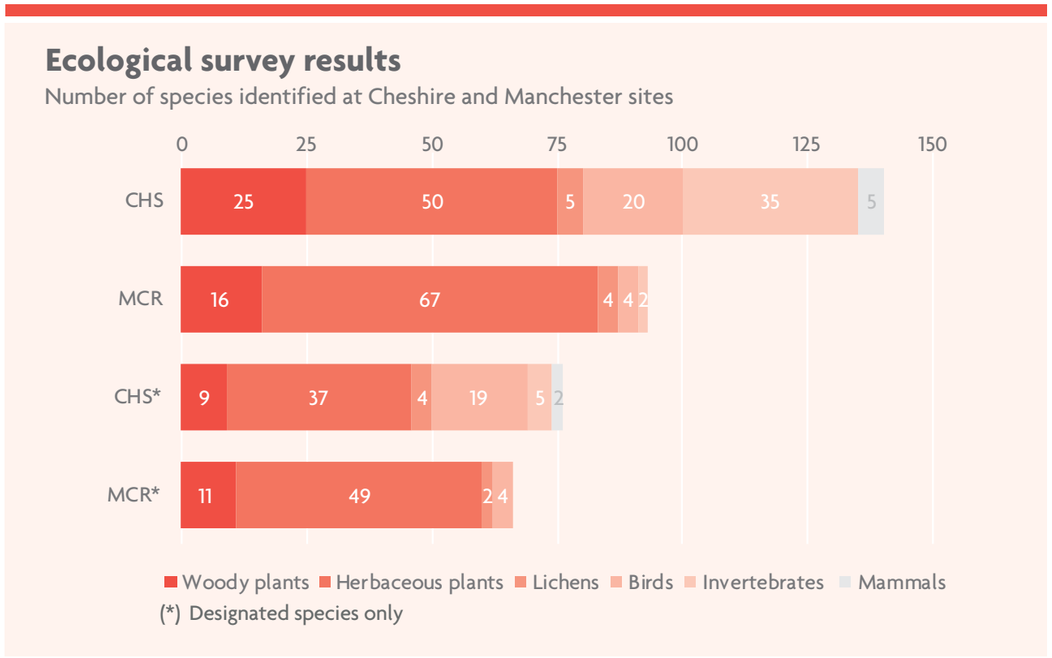
During the first two years, staff from the Environment Partnership (a medium-sized environmental consultancy) contributed to education and training. Two local community organisations (Hulme Community Garden Centre and Lancashire Bat Group), a local historian, and two amateur wildlife watchers have also provided specialist and in-depth local insights.

Students from Manchester Met's Environmental Science and Biology courses have so far taken part in Bio-campus Project activities including undergraduate and postgraduate assessed projects, and completing short-term placements and attending ecological surveys.

The innovation of the Bio-campus Project was to engage with a range of stakeholders in developing the service of ecological surveys. An important benefit from participatory approaches is increased capacity building[4]. This project successfully demonstrated increased capacity building by establishing an ongoing




▲ **Figure 2. Manchester Metropolitan University campus. A: Location of the Manchester and Cheshire campuses in the north west of the UK. B: Manchester campus of All Saints. C: Manchester campus of Birley. D: Manchester campus of Platt Lane. E: Manchester campus of Rybank Fields. F: Cheshire campus habitat types: 1) urban park; 2) formal sports training ground; 3) brownfield with natural succession; 4) stream; 5) fenced woodland; 6) amenity grassland; 7) wetland; 8) community orchard; and (*) green roof.**




▲ **Figure 3. Results of the ecological surveys conducted to identifying 142 legally designated plants and animals. CHS = Cheshire campus. MCR = Manchester campus.**

ecological monitoring system including surveying, data storage, analysis, and reporting mechanisms.

Maintaining stakeholder interest and commitment could be a challenge in participatory approaches[2]. The Bio-campus Project dealt with this challenge by allowing stakeholders to contribute on their own terms, clear communication, coordination and continuous support. Allowing flexibility when engaging with stakeholders was a key lesson learnt from this project.

A delay in implementation, due to the increased time required to accommodate the needs of stakeholders, is another challenge in participatory approaches[4]. The differences in the annual academic, grounds maintenance, and environmental management reporting cycles was a challenge for the Bio-campus Project. These differences had to be anticipated and worked around when planning the surveys.

## ECOLOGICAL DATA: BEYOND LEGAL COMPLIANCE

Legal compliance and strategic purposes are the main drivers for corporate organisations to consider when implementing biodiversity into their practices[5]. In the UK, all public sector bodies, including universities, have a legal duty to consider biodiversity when exercising their functions and all planning applications must comply with relevant wildlife legislation.

The outcomes of the Bio-campus Project are central in helping to meet the university's biodiversity obligations. Firstly, data from the ecological surveys identify a range of designated plants and animals on campus. Secondly, in the long term, annual monitoring will record wildlife changes and inform operational guidance to grounds staff accordingly.

The ecological surveys carried out to date have identified 233 species of plants and animals on campus, of which 142 are legally designated (**Figure 3**). From the 142 designated species, 127 are of least nature conservation concern (i.e. 110 species are not threatened and 17 species can be controlled). However, the remaining 15 designated species found on campus have some conservation interest (**Table 1**).

Unintentional disturbance during day-to-day operations is a legal concern[1]. Knowing the presence of the designated species on campus (**Table 1**) has provided information to grounds staff that has helped them avoid unintentional disturbance (e.g. locations



▼ **Table 1. Designated species found on the Manchester Metropolitan University campus. Bern A2 = Bern Convention Appendix 2. NI Priority = Northern Ireland Priority Species List. WCA Sch5 = Wildlife and Countryside Act 1981 (Schedule 5). RedList VU = vulnerable. RedList NT = close to vulnerable. Scottish List = Scottish Biodiversity List. WCA Sch8 = Wildlife and Countryside Act 1981 (Schedule 8). RedList WL = awaiting listing.**

| Species | |
|---|---|
| *Carduelis carduelis* **Goldfinch** | **Bern A2** |
| *Certhia familiaris* **Treecreeper** | **Bern A2** |
| *Dendrocopos major* **Great spotted woodpecker** | **Bern A2** |
| *Erithacus rubecula* **Robin** | **Bern A2** |
| *Parus major* **Great tit** | **Bern A2** |
| *Sitta europaea* **Wood nuthatch** | **Bern A2** |
| *Troglodytes troglodytes* **Wren** | **Bern A2** |
| *Prunella modularis* **Dunnock** | **NI priority** |
| *Turdus philomelos* **Song thrush** | **NI priority** |
| *Meles meles* **Badger** | **WCA Sch5** |
| *Eriophorum angustifolium* **Common cottongrass** | **RedList VU** |
| *Geranium sanguineum* **Bloody crane's bill** | **RedList VU** |
| *Lepidium coronopus* **Swine cress** | **Scottish List** |
| *Primula vulgaris* **Primrose** | **WCA Sch8** |
| *Senecio vulgaris* **Groundsel** | **RedList WL** |



and habits of species). The ongoing monitoring of data will continue feeding directly into and updating operational guidance to grounds staff.

Strategic advantages for universities to consider biodiversity on a campus could include a positive interaction with nature, increased land values, reduced grounds maintenance costs, greater nature conservation, and the demonstration of good practice[6]. The data and capacity building generated by the Bio-campus Project until now has focussed on identifying a baseline of species, but this could be expanded to include projects contributing to these strategic purposes.

## INFORMING CAPITAL AND MAINTENANCE PLANS

Academic staff and students involved in the Bio-campus Project have developed an ecological surveying service which is directly used by the university's Estates Directorate. Since integration allows capacity building, such integration of work completed by academic departments into the practices of estate operations is considered a key benefit of participation[2].

Work in a real life setting and the interactions with different experts and peers has facilitated social and experiential learning. The outcomes of the learning process included improved ecological knowledge, the establishment of surveying protocols, and the creation of data storage and reporting mechanisms. These outcomes demonstrate capacity building for individuals involved (i.e. skills development) and for the university's Estates Directorate (i.e. service and system development).

The voluntary time and effort in delivering the ecological service and related collaborative projects demonstrate the shared ownership of, and responsibility for, the biodiversity management system amongst the stakeholders. Voluntary time indicates commitment, but also it reflects the resource costs of participation.

The Bio-campus Project has generated data that is feeding directly into the biodiversity action plan, management and maintenance recommendations, and nature conservation recommendations to the grounds team and contractors. Furthermore, these data are helping to identify the wildlife related legal obligations on campus and provides specialist input into the design of capital projects.

## EVOLVING PROJECT

The Bio-campus Project is ongoing and developing. Until now it has shown that engaging multiple stakeholders in developing a service of ecological surveys is possible, but challenging. Also, the project has established processes that directly support the delivery of the biodiversity management system, and has generated data that informs existing capital and grounds maintenance plans. Furthermore, the participatory approach of

CASE STUDY

the Bio-campus Project has resulted in the benefits of co-creation and common ownership of parts of the university's EMS.

However, participatory approaches are also time and resource intensive, and require continuous support and encouragement. In resolving these challenges, co-creation becomes staggered and needs long-term coordination and thinking. The benefit is that long-term coordination and thinking may facilitate emergent systems and qualities, which are the ultimate goals of a Living Lab. ES

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# Gamification in a Living Lab: Energy saving challenges in student halls

**Regine Sønderland Saga** and **Rachel Dunk** look at the potential use of current information and communication technologies in the management of energy in student multi-occupancy housing.




ANALYSIS

In recent years, the concept of the 'Smart City' has emerged as a central theme in the sustainable urbanism discourse. Though the concept is somewhat ambiguous, there is a general agreement that Smart Cities address urban challenges by engaging citizens in the use of information and communication technologies (ICTs)[1]. In order to facilitate user-centric innovation processes, some Smart City research adopts a 'Living Lab' approach. In this context a Living Lab approach:

*"Offers a collaborative platform where professionals from different disciplines work together with future users and public and private stakeholders to generate solutions that are rooted in the dynamics of daily life practices"*[2].

As large institutions, which can in and of themselves be considered analogous to small cities, universities are playing an increasingly important role in the urban sustainability debate, where some university campuses are emerging as Living Labs to address challenges such as energy saving measures in buildings. Financial savings are a key driver for reducing energy use in buildings, while occupant behaviour is a key determinant of energy use. In student residences, the landlord–tenant relationship between a university and its students, where utility costs are typically included within an overall charge for accommodation, eliminates the financial driver for students to engage in energy saving behaviours. Student residences thus present a prime example of a landlord–tenant 'split-incentive' scenario – a well-known barrier to reducing energy use in buildings. In addition to this, student residences are also an example of multi-occupancy housing (MOH), where differing attitudes and preferences amongst occupants may limit the potential for behavioural change to deliver energy savings.

Manchester Metropolitan University (Manchester Met) is participating in the European Union Horizon 2020 funded Triangulum project which aims to demonstrate Smart City solutions and facilitate their replication with a strong focus on the co-creation of solutions with citizens. Here we present an overview of a Living Lab case study at Manchester

Met that aims to address the split-incentive barrier to energy saving behaviour in student residences through the development and implementation of smart solutions.

## THE CASE STUDY

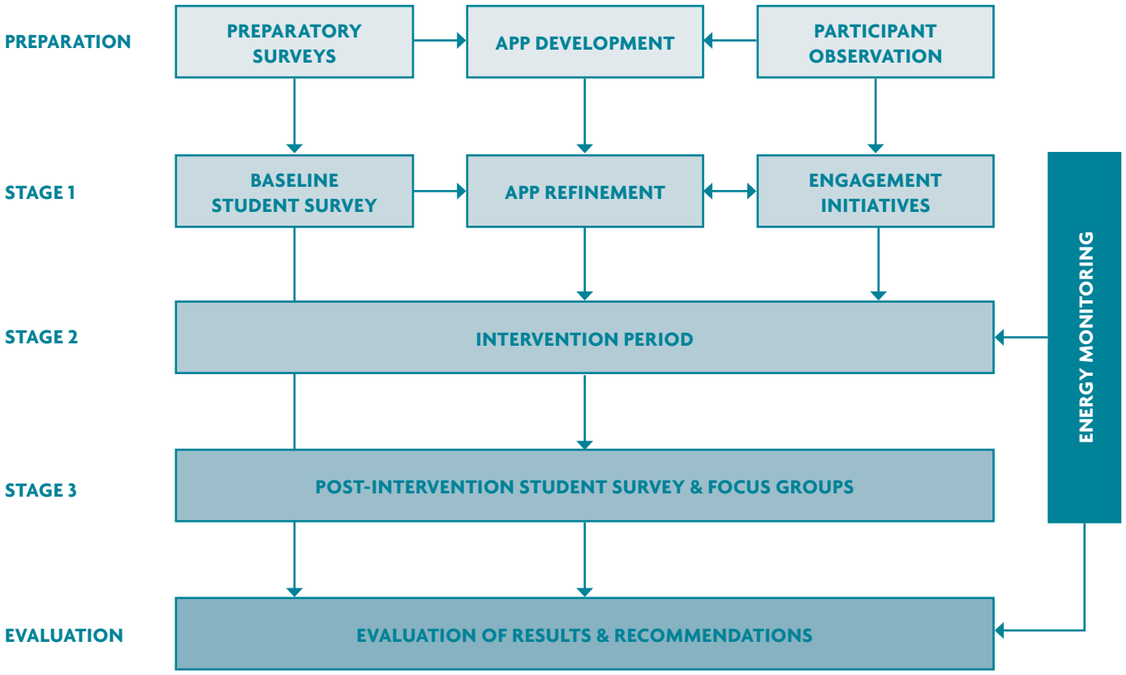
Opened in 2014, Manchester Met Birley campus includes student accommodation in the form of two blocks of halls comprising 37 flats, housing eight students per flat (all rooms are en-suite) and three blocks of townhouses comprising 56 flats housing 12 students per flat (one bathroom shared between two rooms). The student residences were built to high energy-efficiency standards and with real-time energy monitoring at both the flat and block level. Based on building design performance, the accommodation therefore, offers multiple replicates of flats with identical energy demand, where the only variable in determining actual energy use will be occupant behaviour.

This study adopts a user-centric, cross-sectional, collaborative Living Lab approach to co-create and test the success of behaviour change initiatives, including application (app) based gamification, in order to deliver energy savings and thereby reduce carbon emissions in a split-incentive scenario in MOHs. A schematic showing the study stages is presented in **Figure 1**, while **Table 1** presents a summary of the stakeholders and their roles.

The study involves collaboration between academic researchers and a range of stakeholders, including Manchester Met's Services Group, students, Clicks+Links[3] (a small to medium sized enterprise partner in the Triangulum project with expertise in smart solutions) and Manchester Student Homes (a housing service for students owned and managed by all of the Manchester universities).

The initial preparation phase focused on gathering data to inform and shape the implementation phase. Key activities included two questionnaire based stakeholder surveys, participant observation, and app development.

The first survey targeted all Manchester Met students and collected data about their self-reported environmental and technological attitudes, perceptions and behaviours; this survey also served as the pilot for the student baseline survey. The second survey targeted Manchester Student Homes landlords who provide university approved accommodation. While students not residing in university accommodation and private




▲ **Figure 1. The stages in the Living Lab study.**





▼ **Table 1. Internal and external stakeholders and their roles in the Living Lab study.**

| | Internal | | External | |
|---|---|---|---|---|
| Stakeholders | **Students** | **Services Group: Student Living & Environment Team** | **Clicks+Links** | **Manchester Student Homes Landlords** |
| Roles | Attitudes & perceptions | Advise on challenges & barriers | | Attitudes & perceptions |
| | Energy behaviours | Energy behaviours | | Advise on student energy |
| | | Advise on app development | Lead app development | |
| | Participate in initiatives, including app gamification | Lead initiatives, including app gamification | Monitor app usage | |
| | Participate in evaluation of initiatives, including app gamification | Participate in evaluation of initiatives, including app gamification | Participate in evaluation of app gamification | |

sector landlords were not active participants in the implementation phase of this study, it was considered important to collect data regarding their attitudes and perceptions in order to place this study in a wider context, and thereby help ensure that the findings were more broadly applicable. Participant observation was carried out over a one year period where a researcher was embedded in the university's Environment Team for one day per week to identify and address potential challenges to implementation. App development was led by Clicks+Links in collaboration with the Environment Team and researchers at Manchester Met.

Through the app, students will be able to see their real-time energy consumption and compete against other flats in 'energy saving missions'. The missions will be sent as notifications and students will be able to accept the missions or decline to participate.

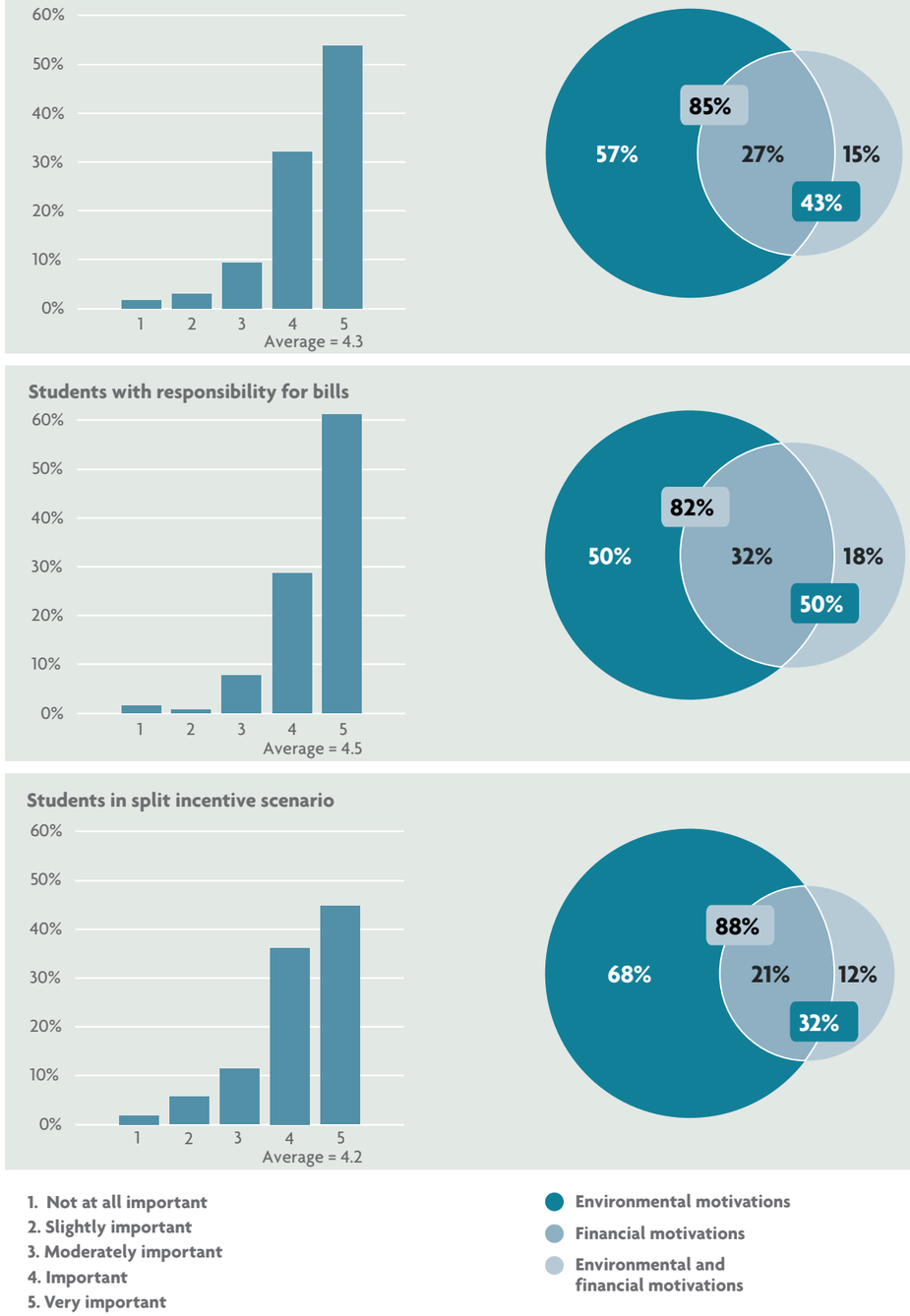
The implementation phase started in September 2017, when students moved into their university accommodation, and will end in June 2018 when they move out. Baseline data will be collected during Stage 1. Stage 2 is the active intervention period, during which engagement initiatives, including app based gamification, will be trialled. Continual monitoring of energy consumption data throughout the implementation phase will allow the comparison of energy usage before, during and after engagement initiatives, and will enable an impartial assessment of their success and longevity in terms of reducing energy demand. Post-intervention student surveys and focus group discussions will feed into an evaluation of the engagement initiatives, which will also include a comparison of students' self-reported attitudes, perceptions and behaviours together with their level of engagement during the intervention period (e.g. active engagement with app missions) as well as actual energy usage.

## PRELIMINARY FINDINGS FROM PREPARATORY SURVEYS

Responses from both the student and landlord surveys indicated that around half of Manchester Met students living in rented accommodation are in a split-incentive scenario where energy bills are included in their rent. Preliminary results suggest that there is a gap between students' and landlords' perceptions regarding student energy behaviours and the potential impact of students being able to see their real-time energy consumption. Overall, of the 234 students surveyed living in rented

## Student views on energy conservation

Left: Student perceptions of the importance of energy conservation ranked on a scale from not at all important (1) to very important (5). Right: Students' stated motivations for energy conservation.




▲ **Figure 2. Student's perceptions of the importance of and motivations for energy conservation.**





| Seeing my real-time energy use would encourage me to conserve energy because... | Having a smart meter or monitor didn't encourage me to conserve energy because... | Having a smart meter or monitor did encourage me to conserve energy because... |
|---|---|---|
| "...if I had a little progress bar that told me how much i was using I'd be much more aware of and able to prevent my energy wastage." | "...[it only showed] numbers I don't understand and didn't really have a severity level (showing what's good, bad and average)." | "...[it displayed a] smiley face and a green background when we used little energy." |
| "...if I knew the average amount that a person was using and I was using more, I would want to cut down." | "...it tell [sic] me what it's currently using however it should also come up with [a] message [...] warning when I'm using more than average amount daily or weekly. Just because it displays numbers doesn't mean anything." | "...it would show how much energy is being used in the household at that time represented by colours; green, orange and red. When it is red or a large amount of orange it encourages us to use less energy, by switching things off or using them for a short amount of time." |
| "...I'm quite competitive so I'd probably be trying to beat my daily best for less consumption." | | "...it reminded me of how much energy I have used and how much I have saved from previous day or week." |
| "...gamification [...] would make it easy to turn the abstract concept of saving energy into a tangible concept and remind you how much you should/shouldn't be using." | | |

▲ **Figure 3. Quotes illustrating the importance of cues, context and challenge setting when providing energy consumption information in order to motivate energy conservation.**

accommodation, 98 per cent placed some degree of importance on reducing their energy consumption, although the level of importance was somewhat lower for students in a split-incentive scenario compared to those with responsibility for paying their own bills (**Figure 2**). Explanatory comments were provided by 188 of the respondents, all of whom placed some importance on conserving energy. The two principal motivations that emerged were the environmental and financial benefits, with a number of students also referring to issues relating to security of supply. Interestingly, environmental motivations were identified by a higher proportion of students than financial savings, even amongst those with responsibility for their energy costs (**Figure 2**). Conversely, and of interest to the study, some students in a split-incentive scenario identified financial savings as a motivating factor (**Figure 2**).

Of those students with some experience of smart energy meters, monitors, or thermostats (112 students), only two-thirds reported that having these devices had encouraged them to conserve energy. Associated comments (64 students) revealed that the way in which information was presented was an important factor in effecting energy efficient behaviour, particularly the use of intuitive easy to interpret visual cues and the provision of context (**Figure 3**). However, when all students were asked how useful it would be to know their real-time energy consumption, 97 per cent thought it would be useful to a greater or lesser extent, with a broadly similar response from students with responsibility for paying their bills and those in a split-incentive scenario (**Figure 4**). In the associated comments (182 students), respondents noted that "Seeing the information makes it real", with many comments (of direct relevance to the design of a smart energy conservation initiative) reiterating the importance of cues and context, and highlighting the motivating force of setting challenges (**Figure 3**).

In comparison, 44 landlords thought that real-time energy information would be of less use to students, particularly when bills are included in rental charges (**Figure 4**). In the associated comments, around a quarter of the landlords expressed the viewpoint that students are not interested in their energy consumption. For those landlords who thought it would be useful, 25 cited financial reasons, with only seven citing environmental reasons. These results suggest that landlords hold a misconception regarding students (self-reported) attitudes towards energy saving. Interestingly, the survey also revealed that around a third of landlords wished to


▲ **Figure 4. Perspectives on how useful it would be for students to see their real-time energy consumption.**





improve the communication between themselves and students regarding energy usage and billing, noting that if the students knew their real-time consumption they could better advise them on energy conservation.

As noted previously, these preliminary results will inform the design of engagement initiatives and app based challenges to be employed during the project implementation stage, where there are encouraging indications that provision of contextualised information using intuitive visual cues and app gamification could change student energy behaviours. Furthermore, this study has identified that landlords hold misconceptions about students' attitudes and perceptions regarding energy conservation. This study will seek to bridge this gap during the implementation and evaluation phases by actively engaging all stakeholders in the innovation process, thereby boosting cross-sectional communication, increasing engagement with energy related ICTs, and ensuring the design of energy related ICTs are fit for purpose. If app based gamification is proven to encourage energy conservation in this case study, then replication in other split-incentive scenarios could contribute further to addressing this urban sustainability challenge. **ES**

**Acknowledgements**

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CASE STUDY

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# Creating a campus-scale laboratory for low carbon energy research

**Zoe Robinson** and **Ian Madley** describe the application of the Living Lab approach at Keele University, to research and develop smart energy strategies and technologies in partnership with the local community, and the importance of making 'invisible' sustainability projects 'visible', in order to maximise educational potential.

Keele University is at the start of a major development which will transform the campus into a 'Living Laboratory' (commonly known as a Living Lab) for experimentation with low carbon energy solutions. Keele University is a 615 acre mixed use campus university, incorporating staff and student housing, sports, catering and entertainment facilities, and academic and commercial uses (**Figure 1**). As a substantial campus university, Keele operates its own sizeable energy distribution network, giving it control over its own energy infrastructure as well as having total responsibility for its energy and carbon costs. Its size and mixed use makes it analogous to a small town, and an ideal laboratory for researching at-scale low carbon energy solutions, hence these developments will see the entire campus become a living and working environment that is controlled and managed to minimise carbon use – a genuine Living Lab.

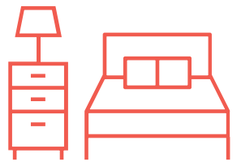
CASE STUDY

**615 ACRES**

**341 BUILDINGS**

**10,000 STUDENTS**

**2,000 STAFF**



**3,000 STUDENT RESIDENT ON-CAMPUS BEDROOMS**

**189 STAFF RESIDENTIAL PROPERTIES ON SITE**

**70 ACRE DEVELOPMENT SITE**

▲ **Figure 1. Keele University combines residential, sports, catering, and entertainment facilities with academic and commercial use buildings, making it analogous to a small town.**

Keele's Smart Energy Network Demonstrator (SEND) aims to establish the campus as a national research and development facility, creating an at-scale Living Lab where smart energy strategies and technologies can be researched, developed and tested in a real world environment in partnership with businesses and industry, as well as meeting ambitious carbon reduction targets (**Box 1**). This will make the campus the largest single integrated electricity, gas and heat SEND in Europe. The SEND project will provide the facilities for experimentation for businesses to work collaboratively with researchers and PhD students to create, test, and deploy smart products, services and business models for the global low carbon market. The research will not just be technical, but will also allow behavioural research on consumers, the exploration of individual user behaviour and overall system demand.

## WHAT IS A SMART ENERGY NETWORK?

A smart energy network is not just one thing. It incorporates:

- the collection and management of performance data;
- the inter-operability of different smart grid products;
- new business models;
- the deployment of advanced technologies within existing power systems;
- the integration of distributed energy systems and micro grids; and
- energy storage solutions and demand response programmes.

As an experimental facility the exact solutions and directions will come from businesses, but may incorporate innovative energy storage solutions, such as vehicle-to-grid, and different scale technologies utilising wind and geothermal energy.

## A LIVING LAB WITH A DIFFERENCE?

There are variable definitions of the Living Lab concept in Higher Education institutions. One commonality is that sustainability-focused Living Lab projects achieve their maximum potential when the university's research, educational and facilities objectives are fulfilled. This can operate on a small scale, involving a single student carrying out research for their course on an issue relating to the sustainability of the university estate, to more university-wide coordinated approaches. The SEND project extends the definition of the Living Lab in several ways.

As the SEND project will turn the whole campus into a laboratory for experimentation, all of the staff and student population become both the subjects of research as energy users and consumers, as well as the potential researchers. Researching the participants of the campus community as part of these projects can be done in different ways: 1) observational – using monitoring devices to observe how something is utilised in order to try to understand the interactions between people and an aspect of their environment (i.e. how different users use energy); 2) interventional – making small changes to an aspect of the campus, and exploring if and how this affects behaviour; and 3) manipulative/nudge – directly seeking behaviour change through an intervention for example, through financial incentives or communication of information.

The SEND project also has a strong association with businesses in several different ways which are often not incorporated in many Living Lab definitions: 1) businesses with expertise in smart energy networks are a key part of the delivery of the project infrastructure; 2) businesses will use the Keele 'laboratory' to develop and trial new products and services; and 3) the SEND project will be used to increase local business capacity in low carbon and smart energy activities thereby stimulating economic potential in this field and geographic region. Thus the inclusion of 'business activity' into a Living Lab brings with it many advantages to businesses, the university and to the wider economy. It also highlights that universities do not necessarily have all the answers and that much cutting-edge technological research is carried out by businesses, suggesting that Living Lab projects which do not integrate with the wider community, may not achieve their full potential.

## A HIDDEN CURRICULUM

Much of the emphasis of the Living Lab approach has been on campuses as places of experiential learning both for and about sustainability through student projects. There has been a limited amount of work completed on the impact of the institutional environment itself on student learning and behaviour (i.e. the 'hidden' curriculum)[1]. Despite an increasing number of flagship sustainabile buildings on campuses across the world, there has been even less research into how the campus can be used explicitly as an educational tool for sustainability, and one which considers the education of both students and staff. Discussion of the hidden curriculum in relation to sustainability education is often in a negative sense, referring to contradictions between sustainability rhetoric and teaching, and the comparatively poor sustainability of the estate.

**BOX 1: THE SMART ENERGY NETWORK DEMONSTRATOR (SEND) PROJECT**

**Funded by**

- Keele University
- Department for Business, Energy and Industrial Strategy
- European Regional Development Fund (part of the England 2014 to 2020 European Structural Investment fund (ESIF) growth programme)
- Linked to 20 PhD studentships

**Institutional targets**

- First integrated energy demonstration system in Europe
- Protect self from energy price hikes
- Improve energy infrastructure
- Leaders in energy research
- Develop national research and development facility

**Funder targets**

- 30 per cent carbon reduction per annum (4096 $tCO_2^e$/a by end of 2021).
- 243 companies to receive support, 26 of which working with PhD students
- 15-20 companies to have first time engagement with a research-based institution
- 7 'new to the company' products
- 5 business start-ups

**Additional area of potential**

- Significantly increase energy literacy of staff and student community

One of Keele University's six strategic aims is "To promote environmental sustainability in all that we do" including the objective to "Educate our students on environmental issues and provide opportunities for them to put strategies into practice"[2]. Despite these aspirations, within the initial stages of the SEND project, no specific educational objectives were outlined, yet there is tremendous potential for a campus-wide project to be used to educate the staff and student population on energy sustainability to maximise the project's full potential.

Educational opportunities associated with these developments could include: 1) increasing engagement in energy issues and enhancing energy literacy amongst all the staff and student community through effective communication of the SEND project; and 2) integrating aspects of the SEND project into the curriculum of specific disciplines using them as case studies or for student projects.

One of the difficulties with the first aspect is that energy is invisible and the ultimate aim of SEND is as a demonstrator for how low carbon energy solutions can be deployed with minimal disruption to consumers. For example, the project could explore the energy storage potential in being able to temporarily switch off the approximately 400 on-campus freezers. A mark of success of such an intervention would be that the users would be unaware of it; yet this would not help them to engage with and understand energy use. However, if at the same time we can work to make energy 'visible' through detailed energy profiles of different appliances or for individuals or groups of individuals, and effectively communicate project developments, this could act to increase energy literacy and influence behaviour.

There are many examples of sustainable buildings in universities across the world, yet the extent to which the sustainable elements are communicated to the community that use these buildings is variable. Keele's major energy project offers the potential to research ways of educating by 'making the invisible visible' through traditional means, such as interpretation boards and through digital communication. This would help us to understand how to communicate 'hidden sustainability' in order to foster transformative learning.

The discipline areas most obviously aligned with the SEND project are Engineering and the Built Environment, neither of which are key curriculum areas at Keele University. There are other potential synergies between the energy projects and other disciplines, as well as opportunities to learn about skills such as project management, but the question remains of how to incentivise programme leaders to make these links in their programmes. Such an approach also creates a 'patchy' coverage of engagement, although the project has relevance to all users albeit in a hidden way.

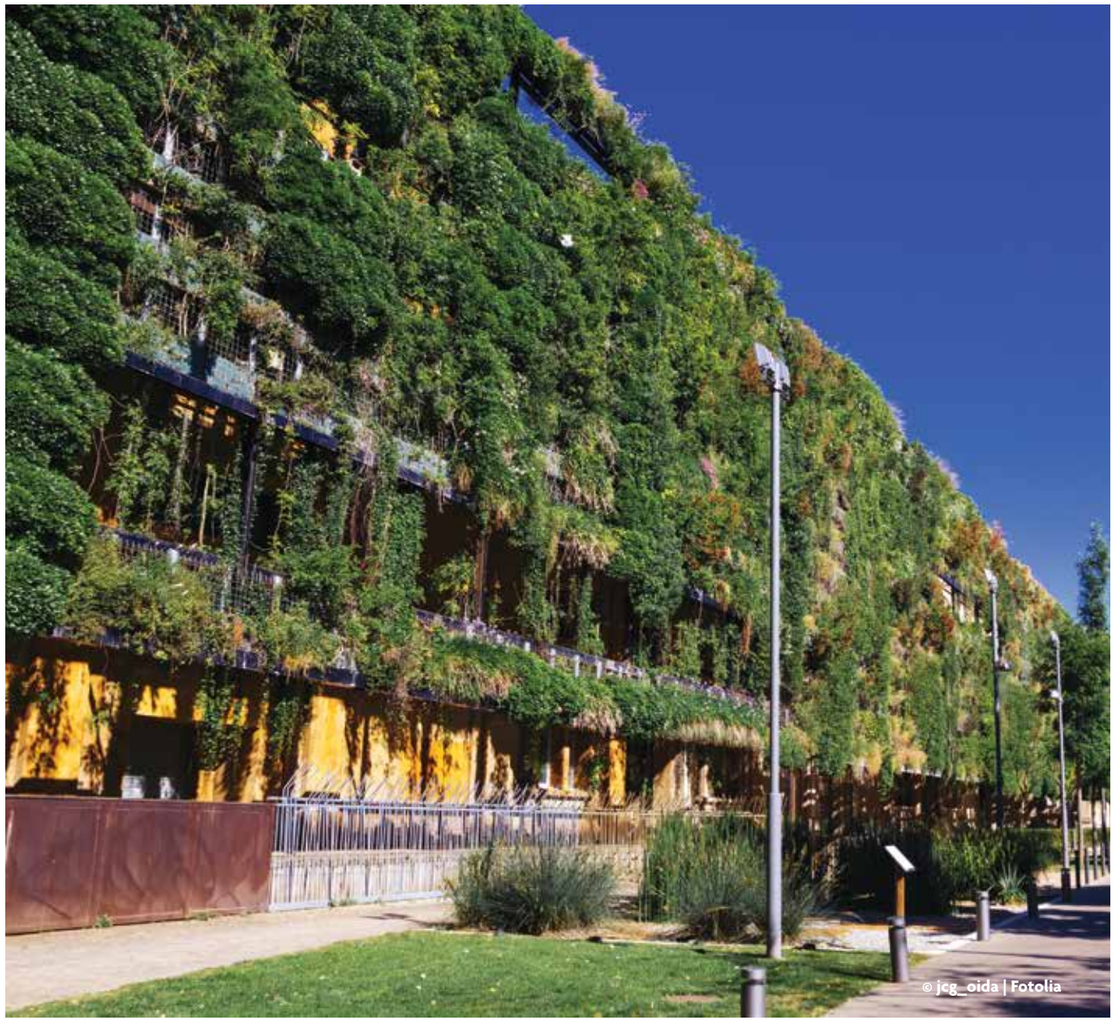
Ultimately, the use of the campus as a tool for sustainability education presents the opportunity to develop a "Subject neutral forum"[1] able to counter Orr's claim that the campus is the "Source of no useful learning"[3].

## WHAT IS THE WAY AHEAD?

University campuses have great potential as Living Labs to explore sustainability solutions at the scale of a small town, utilising both the university's research expertise as well as providing the facilities for research by businesses and outside organisations. In order to maximise the potential







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of such projects, it is important to combine facilities and research objectives as well as educational and business engagement targets. In all likelihood, most projects will develop with a focus on two or three of these areas, and it is therefore worthwhile assessing the potential for incorporating other aspects in order to realise the Living Lab's full potential. If the challenges of making invisible sustainability issues visible are tackled, then a campus-wide Living Lab has potential for increasing the sustainability literacy of the whole campus community. ES

**Acknowledgements**

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# The EcoCampus initiative: Sustainability in Nanyang Technological University

**Ryan Jin Zhanhe** describes the work of the Nanyang Technological University in using the Living Lab concept to revolutionise sustainable research in Singapore.


CASE STUDY

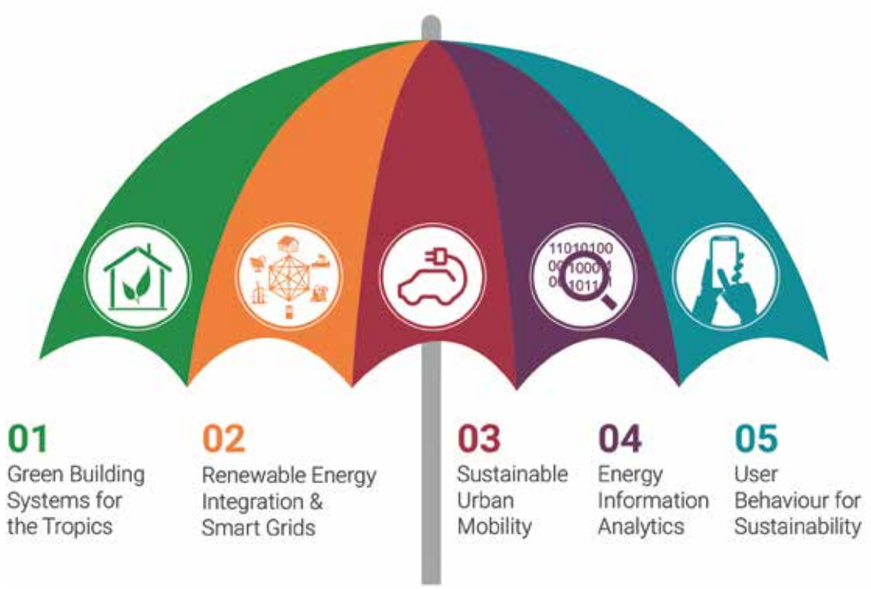
Nanyang Technological University in Singapore (NTU Singapore) is ranked 11th in the QS World University Rankings (2017)[1] and started developing a niche in sustainable development and urbanisation in the 1990s, in response to Singapore's need for new and reclaimable sources of water. Under its five-year strategic blueprint[2], NTU Singapore developed 'Five Peaks of Excellence', one of which is a 'Sustainable Earth'. This takes a comprehensive approach to water issues, alternative energy sources, clean technologies, urban systems and geological concerns. Centres engaged in sustainability research at NTU Singapore include the Earth Observatory of Singapore, Singapore Centre on Environmental Life Sciences Engineering, Nanyang Environment & Water Research Institute and Energy Research Institute @NTU.

NTU Singapore aspires to be the most sustainable university in the world, dedicating itself to the idea of being a 'Living Laboratory'. Some of the new buildings in NTU Singapore such as The Hive (**Figure 1**) are fitted with new and innovative sustainable technology like the Passive Displacement Ventilation system.

NTU Singapore are working closely with government agencies, such as the Singapore's Economic Development Board (EDB), the Building Construction Authority, the Energy Market Authority , the JTC Corporation (JTC), the National Research Foundation, and the National Environment Agency (NEA) to develop practical solutions that will put Singapore in the forefront of research on energy efficiency and sustainable development in the region. Some of the work undertaken by NTU Singapore includes the 'EcoCampus Initiative' in NTU Singapore Yunnan campus and the 'Renewable Energy Integration Demonstrator Singapore' (REIDS) in *Pulau Semakau* (Semakau Island) – Singapore's first and only landfill situated offshore among the southern islands of Singapore.

◀ **Figure 1. The Hive NTU: Innovation in learning and sustainable building technology.**

▲ **Figure 2. Launch of NTU EcoCampus Initiative (© Nanyang Technological University Singapore).**




▲ **Figure 3. The EcoCampus initiative's research, development and deployment focus areas (© Nanyang Technological University Singapore).**

The EcoCampus Initiative was officially launched in 2014 (**Figure 2**) by Minister S. Iswaran, Minister for Trade and Industry, to develop a novel campus-wide sustainability framework, with demonstration sites, to achieve a 35 per cent reduction in energy, water and waste by 2020. The EcoCampus Initiative also aspires to serve as an open learning platform where most of its findings will be shared to serve as an inspiration and reference to be the 'greenest campus in the world'.

In partnership with Singapore's EDB and JTC, the EcoCampus Initiative will transform NTU Singapore's 200 ha campus into a 'super test bed' for research projects in cutting-edge green technologies with leading industry partners.

In order to achieve the EcoCampus Initiative's goals for energy, water and waste, it is currently undertaking projects that fall under five focus areas (**Figure 3**)[3]:

1. Green Building Systems for the Tropics.
2. Renewable Energy Integration and Smart Grids.
3. Sustainable Urban Mobility.
4. Energy Information Analytics.
5. User Behaviour for Sustainability.

## GREEN BUILDING SYSTEMS FOR THE TROPICS

The Green Building Systems for the Tropics focus area addresses tropical building envelopes and façade technologies, lighting types, provision of energy efficient indoor air quality (cooling, ventilation and dehumidification systems), and innovative data centre cooling technologies. One such relevant project, in collaboration with Siemens, is entitled "Intelligent, demand-based, Algorithmic Chiller Optimisation for Buildings in the Tropics". Siemens' 'Demand Flow Technology' is a chiller optimisation tool which helps to improve chiller plant efficiency and maintain uniform and comfortable living conditions within a building (**Figure 4**). This project also has an objective to achieve this with minimum investment and reduced operating costs. By the conversion of a constant speed system to a variable one (except the chillers) and the implementation of Siemens' control logic and demand flow algorithm, an improvement in chiller plant efficiency ranging from 12 to 15 per cent during the test period has been achieved. Performance monitoring is to continue with the use of an automated system along with the development of implementation plans for other sites.

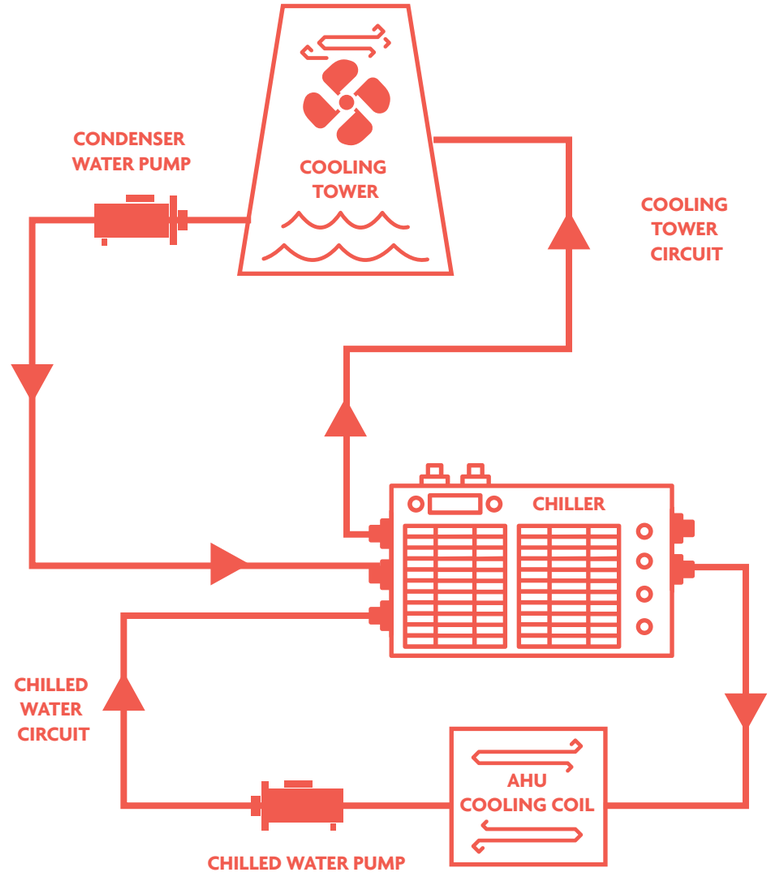
## SUSTAINABLE URBAN MOBILITY

The Sustainable Urban Mobility focus area concentrates on working towards the Government's aim of making Singapore a Living Lab within industrial, residential and mixed-use developments, and tests new mobility concepts as well as helping the development and commercialisation of urban mobility solutions (**Figure 5**).

NTU Singapore is currently testing 'ARMA', an electric driverless shuttle bus. Developed by the French company NAVYA, ARMA will be the largest autonomous vehicle at the Institute; a driverless, air-conditioned shuttle that can carry up to 15 passengers. It will travel between the adjoining 50 ha CleanTech Park and the NTU Singapore campus, and when running, the ARMA shuttle will reach speeds up to 40 km/h with a range of 130 km on a fully charged battery.

All of the mobility projects described lay the foundation for the latest 'Mobility-as-a-Service' (MaaS) testbed where NTU Singapore, JTC and SMRT Services Pte Ltd jointly develop innovative solutions that seamlessly integrate multiple modes of transportation, for better connectivity and accessibility. They also all work towards Singapore's vision of a car-lite society as the MaaS solution will seamlessly integrate train and bus networks with next-generation transport modes, such as electric automated vehicles, on-demand ride sharing, bicycle sharing systems and personal mobility devices such as E-scooters and E-Bikes.

To complement NTU Singapore's efforts in autonomous vehicle research, the Land Transport Authority and JTC, in partnership with the NTU Singapore, launched the Centre of Excellence for Testing & Research of Autonomous Vehicles (NTU SINGAPORE




▲ **Figure 4. Typical water-cooled chiller system (© Nanyang Technological University Singapore).**


▲ **Figure 5. A range of sustainable mobility solutions constitute an on campus testbed (© Nanyang Technological University Singapore).**

[CETRAN]). The centre consists of a 1.8 ha test circuit (at the CleanTech Park) with roundabouts, slopes and an area with simulated rainfall, in order to test-run different types of autonomous vehicles. Adaptability to traffic rules, road design and climate are evaluated before their use on public roads. The team is currently incorporating realistic models of autonomous vehicle performance into the simulation platform, which will produce a sophisticated tool for studying, testing and certificating autonomous vehicles which, in turn, will aid the design of the required infrastructure for supporting autonomous vehicles.

## RENEWABLE ENERGY INTEGRATION AND SMART GRIDS

The Renewable Energy Integration and Smart Grids focus area is concerned with smart micro-grid management with alternating current (AC) and direct current (DC) architecture, efficient and low-cost energy storage systems, home energy management systems and demand respond management. An ongoing project "DC Renewable Connected Building Grid for Wireless Intelligent LED Lighting Systems" develops and pilots innovative solutions to reduce energy consumption, increase efficacy of building occupancy, and improve maintenance and human comfort in workspaces of smart buildings. By designing a renewable energy connected building with an internal DC grid, it reduces DC-AC-DC power loss.

## ENERGY INFORMATION ANALYTICS

The Energy Information Analytics focus area is helping to progress towards wireless sensors and communications, smart-metering and monitoring systems, and 'big data' analytics. The current ongoing project includes "3D, Interactive & Dynamic Simulation Tool Using Virtual Environment and Multiphysics Modelling" where the Virtual Environment software of the company, Integrated Environmental Solutions, is employed, enabling NTU Singapore to carry out detailed analysis and assessments for EcoCampus projects. This project aims to simulate different technologies and determine the scale and locations for the deployment of most optimum technologies with maximum energy saving potential such as NTU Singapore's 5,000 kWp Solar PV installation (**Figure 6**). This has been achieved through the development of a virtual multi-physics model of the campus, which can simulate technologies virtually.

## USER BEHAVIOUR FOR SUSTAINABILITY

User Behaviour for Sustainability focus area offers a platform where gamification and sociological concepts for user engagement can be tested. In collaboration with ENGIE Lab Singapore and NTU Singapore, the PowerZee application (app) was developed in 2015 as an engaging smartphone app to foster sustainable behavioural practices and raise awareness about energy consumption on campus. By developing a smartphone virtual experience, the PowerZee app brought together over 2,000 campus users to participate in reducing everyday electricity consumption. A number of touchscreen dashboards can be found on the campus which users can interact with PowerZee and find out more about the campus energy consumption (**Figure 7**). The new version was relaunched in March 2017, and was tested in various universities and polytechnics in Singapore, and beyond.





▲ **Figure 6. Image of the 5,000 kW rooftop solar photovoltaic installation at NTU Singapore campus (© Nanyang Technological University Singapore).**


▲ **Figure 7. A data analytics dashboard for campus energy conservation of the NTU Singapore campus (© Nanyang Technological University Singapore).**


▲ **Figure 8. A plan showing the Renewable Energy Integration Demonstrator on Semakau Island (© Nanyang Technological University Singapore).**

### THE LIVING LAB PROJECT BEYOND NTU SINGAPORE

To support the development of micro-grids in Southeast Asia, NTU Singapore is leading the initiative for REIDS which will be the largest hybrid micro-grid in the tropics (**Figure 8**). This initiative is strongly supported by the Singapore Government, the EDB and the NEA, along with industry partnership.

The multi-million dollar initial micro-grid demonstrator facilitates the development and commercialisation of energy technologies suited for tropical conditions, and is to be developed by NTU Singapore together with a consortium of world leading companies, such as ENIGE, Schneider Electric and more. REIDS and its partners will test and demonstrate, among others, the integration of solar, wind, tidal, diesel, energy storage and power-to-gas technologies, and ensure these energy sources operate well together.

NTU Singapore, a Living Lab for sustainability, has implemented numerous initiatives over the years and is committed to carrying out wide-ranging investigations into other sustainability opportunities, and assisting in planning and target setting. We will continue to focus our efforts in reducing energy intensity to bring us closer to the targeted 35 per cent reduction in energy, water and waste intensity by 2020, and beyond. ES

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# The gap between education and reality

**Kim Croasdale** discusses how students and educators are linking teaching, learning and assessment activities to community and business projects through the Living Labs initiative.

Young people attending university have a wealth of opportunities and learning at their fingertips. They are often living away from home for the first time, learning how to fend for themselves, as well as taking part in new sports, activities and hobbies. They are also able to focus their studies on one particular topic and fully immerse themselves in it.

However, there seems to be a conspicuous gap in many university degrees: applying learning to the challenges of everyday life. Degrees are all too often so tightly focused on their own area that they do not look around to apply their knowledge to other issues. They too readily ignore the world's starkest realities, such as poverty, increasing levels of carbon in the atmosphere and the impact of migration on delicate societal infrastructures. For example: engineering students may not study new technologies such as renewable energies as standard; history students are not automatically taught to apply the lessons of history to today's politics; and an economics degree regularly revolves around out-dated and irrelevant models.

**BOX 1: EDUCATION FOR SUSTAINABLE DEVELOPMENT**

The Higher Education Academy and Quality Assurance Agency define 'Education for Sustainable Development' (ESD) as "The process of equipping students with the knowledge and understanding, skills and attributes needed to work and live in a way that safeguards environmental, social and economic well-being, both in the present and for future generations"[1].

This has not gone unnoticed by students. The Post-Crash Economics Society (PCES), comprised of economics students at the University of Manchester, is one group that has pioneered a student-led movement in this area. They complained that the narrow focus and limited scope of their curriculum did not allow graduates to develop the university-appointed graduate attributes[2]. These attributes state that education should "Prepare graduates for citizenship and leadership in diverse, global environments", but the PCES pointed out that their course was divorced from social, political and philosophical issues. Not only are these issues relegated to optional modules in other departments, pure economics students are actively encouraged *not* to take the modules as they are seen as less valuable[2].

It is becoming far more widely recognised that courses should not only teach the facts but also how to relate their learning to the real world. This would help students to break out of their academic bubble, and experience the world of work and the challenges they will face upon graduation.

In the absence of this formalised teaching, important extracurricular activities such as volunteering offer students the opportunity to develop this learning informally. Over 60 per cent of students volunteer, delivering around 750,000 volunteering hours per year through their students' union[3], much of which is with local organisations. Volunteering provides a valuable chance to develop, learn new skills, gain new knowledge, and importantly, help others to improve society. It is incredibly beneficial for students, allowing them to strengthen their CVs, get work experience, learn from local and global issues and develop important employability skills.

**BOX 2: SUSTAINABILITY & SUSTAINABLE DEVELOPMENT**

The terms 'sustainability' and 'sustainable development' (often used interchangeably) are often misunderstood to narrowly focus on environmental factors and climate change. However, the Brundtland report[5], compiled by the United Nations World Commission on Environment and Development, defines sustainability as "Development that meets the needs of the present without compromising the ability of future generations to meet their own needs". It also states that "Even the narrow notion of physical sustainability implies a concern for social equity between generations, a concern that must logically be extended to equity within each generation". This shows the connection between environmental degradation, social factors and economic development within the term sustainable development.

**"94 per cent of volunteers report that helping their community is their main reason for volunteering."[3]**

In fact, 94 per cent of volunteers report that helping their community is their main reason for volunteering[3]. However, a lack of time due to study pressures is the main reason that students do not volunteer more and that barrier is increasing as universities come under greater pressure to provide courses packed with content. In 2010, almost half of students gave their time to formal volunteering activities benefitting the wider community, but in 2015 that number decreased to just under a third[3,4]. It is important that students' strong, selfless desire to help isn't neglected. Even beyond the above benefits, student volunteers also provide an important additional resource to the companies they volunteer with, especially for charities and non-profit organisations.

Education should reflect the fact that students need to learn about life beyond academia and want to benefit others with their skills and knowledge.

## SUSTAINABILITY AND SOCIAL RESPONSIBILITY

Sustainability, including the economic, social and environmental factors, is the biggest, most wide-reaching and urgent challenge that our world is currently facing, touching the lives of every single person. So what better concept is there to incorporate the real world into the curriculum? By embedding (ESD) in Higher Education courses, we can help students to relate the concept and challenges to their area of interest, potentially coming up with important solutions in the process. Recent guidance from the Higher Education Academy (HEA) and the Quality Assurance Agency for Higher Education (QAA)[1] shows how well ESD can close the gap between education and the real world. It specifically recommends that educators should link teaching, learning and assessment activities to real-life concerns, and that methods, such as experiential project work and problem-based learning, are used.

What's more, students want this to happen. Six years of survey data has shown that over 80 per cent of students believe that their educational institutions should be doing more on sustainability and 60 per cent want to learn more about it[6]. This is valuable motivation for educational institutions to show that they are incorporating sustainability into their curricula. The HEA/QAA guidance also lists graduate outcomes that should result from incorporating ESD. These include knowledge and understanding as well as skills and attributes. They are cross-referenced to four core themes: global citizenship; environmental stewardship; social justice, ethics and wellbeing; and future-thinking[1].

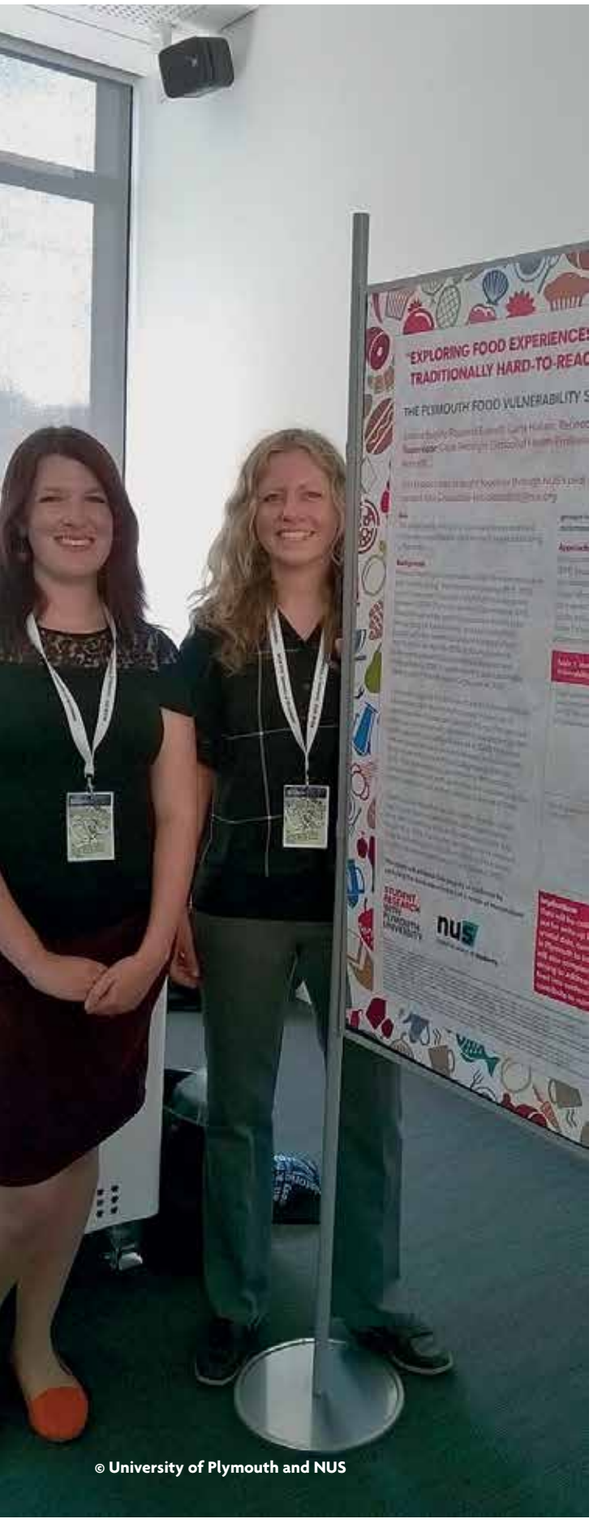
The HEA/QAA guidance, therefore, offers tangible options for how to plug the gap between education and real life, with sustainability as the hook.

## LIVING LABS

Changing curricula is often viewed as a slow, convoluted and tricky process to navigate; it doesn't have to be. The success of student volunteering already shows that students are keen to take on extra responsibilities in order to help others, and surveys from the National Union of Students (NUS) show that students want to work on sustainability projects as well. This is where Living Labs come in.

A recent Environmental Association for Universities and Colleges (EAUC) report stated "Real-world sustainability challenges are formally addressed in stakeholder partnerships"[7]. Living Labs embody this principle by integrating research and innovation processes in real life communities and settings. This approach gives students the much-needed opportunity to use their education and knowledge in practice, by helping to solve problems or answer questions that are being faced by their institution or an organisation. It is an opportunity to formalise the student volunteering roles that are so beneficial for students and organisations alike, and are already so popular. This type of working is becoming increasingly common within universities and between educational institutions, and their local areas; it could truly transform the face of education.

There are a number of trailblazing Living Labs schemes in a wide variety of formats. The University of Sheffield provided students with the opportunity to pitch ideas to solve a question posed by their Estates and Facilities Management Department, which culminated in the winner working alongside the team to implement the project. The University of British Columbia's Social Ecological Economic Development Studies programme



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formalises a similar process by providing structured support for students to work with various non-academic departments at their university. The University of Bristol (UoB) runs 'Engaged Learning' projects, connecting Masters students with local organisations to work together, and Nottingham Trent University Business School's Consultancy Experience Project partners management and business students with local organisations to offer consultancy work. There are also a number of specialist schemes not attached to a specific university but useable by all, such as the International Science Shop Network and the European Network of Living Labs.

The NUS has launched its own scheme called 'Dissertations for Good'[8], which aims to connect students with organisations across the whole of the UK. It is the only scheme that prioritises area of interest over geographical location in order to form partnerships, meaning students from the University of the Highlands and Islands in Scotland could be partnered with an organisation in Devon to work together on groundbreaking research questions. It operates as a broker, putting people together to complete the project as a part of the student's course. There are also opportunities for supervisors to lead on the process of creating a partnership on behalf of their students, and for non-academic departments of universities to take advantage of the wealth of knowledge and expertise in their student body. Projects include evaluating university engagement with Fairtrade accreditation, comparing building performance with expectations based on climate data from the Chartered Institute of Building Services Engineers, working with a digital marketing team to help the Canal & River Trust engage with wider audiences, and assessing the impact of housing adjacent to ancient woodland in cooperation with the Woodland Trust.

The Living Labs methodology is an incredibly important way of boosting student experience, allowing them to relate their learning to actual issues and challenges faced by organisations. Additionally, it fulfils students' desire to help their community by using their education as a force for social good.

These experiences truly show how valuable Living Labs can be. They clearly achieve the target of closing the gap between education and the real world. As one student commented: "Dissertations for Good has given real meaning to my university studies…working for the sake of something greater than my own academic development has given me drive and motivation to work hard".

That learning is enhanced by the opportunity to fulfil their desire to do good and help people. Joanna Leigh, who worked with Islington Council on energy metering, sums it up: "It's satisfying knowing that your work is for a specific purpose that may be of use to somebody".





Supervisors agree that it is an important learning opportunity. Dr Clare Pettinger, Lecturer in Public Health Dietetics at Plymouth University whose students have taken part in the project, has said: "It's been a lesson [for the student] in the challenges of working in the real world" and that "It is a good experience that enhances students' profiles".

And other projects have had similarly high levels of praise and positive feedback. The UoB's Engaged Learning scheme in 2015/16 reported that 93 per cent of the students in the School of Sociology, Politics and International Studies (SPAIS) and 77 per cent of students in Geographical Sciences reported that they found the scheme enjoyable. What's more, 83 per cent and 100 per cent respectively, reported that it enriched their learning and 96 per cent and 100 per cent would recommend it to other students. Importantly, 86 per cent of the students in SPAIS who took part, reported that they have developed important employability skills, and anecdotal feedback proves that these experiences are key to helping students understand the links between their education and the real world[9,10].

Living Lab schemes are truly win-win, as the organisations themselves benefit greatly from the opportunity as well. Many of the schemes target small non-profit organisations in order to help those who have fewer resources, but are trying to make a real difference to society. UoB's Engaged Learning conducted a survey with the students and organisations that took part in the scheme; 63 per cent of those partnered with students from the SPAIS and 100 per cent of those partnered with students from Geographical Sciences said that they would want to take part again in the future. Additionally, 70 per cent of those working with SPAIS students would definitely recommend the scheme and 67 per cent of those working with Geographical Sciences students said they were either 'good' or 'excellent'[9,10].

Similarly, organisations taking part in Dissertations for Good agreed that they benefited from an increased insight and commitment from a student, and that the partnerships had transformative impacts. Dr Anastasia Mylona, Research Manager for the Chartered Institute of Building Services Engineers, found the process "Very rewarding" and said that the process "Confirmed the many benefits of getting involved in the education of [students]".

## WHAT DOES THE FUTURE HOLD?

Sustainable development and all associated issues are global, urgent and cannot be ignored. It is the graduates of today and tomorrow who bear the weight of responsibility to act. In turn, it is the responsibility of educators to ensure that they have the knowledge, skills and ability to act.

The encouraging thing to take away from this is that changes are already happening, and are often being led by students. Students are prepared to stand up and lead the way on embedding sustainability and learning for the real world into their education. We are simply following their lead now, and helping them to take it further by providing schemes such as Dissertations for Good. ES

**Kim Croasdale** worked with the Department for Sustainability at the NUS for 4 years, delivering behaviour change campaigns and setting up and managing Dissertations for Good. She has now moved to the NHS Sustainable Development Unit. Queries should be directed to quinn.runkle@nus.org.uk.

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CASE STUDY



# Turning a university into a Living Lab

**Liz Cooper** describes how the University of Edinburgh has taken a Living Lab approach to solve social responsibility and sustainability challenges through collaborations between researchers and practitioners.

Universities are well placed to contribute to sustainable development, not only through researching solutions to environmental and social challenges, and teaching and inspiring future generations, but also through leading by example in terms of their own business operations. It is now common for UK universities to have a team, or at least an individual, responsible for working to make the institution more sustainable, and a variety of different models exist regarding where these sustainability professionals fit into an organisation's structure[1]. Their remit can include reducing energy use and emissions from buildings, laboratories and transportation, encouraging recycling and reuse, and more recently calling for sustainability in supply chains and shifting to responsible investment.

The University of Edinburgh's Department for Social Responsibility and Sustainability (SRS), which is part of the Corporate Services Group, collaborates with stakeholders across the whole university to make it more socially responsible and sustainable. The SRS works on the following thematic programme areas: climate change and energy; resource efficiency and circular economy; fairness in trade and sustainable procurement; sustainable laboratories; sustainable travel; responsible investment; and community engagement. The SRS also runs staff and student 'Sustainability Awards', provides training and guidance on sustainability issues, develops policy, and works with students and academics on research projects to solve real-life problems relating to university operations (**Figure 1**). The latter is framed by an approach called the 'Living Lab'.

Treating the university as a Living Lab means bringing together operations staff, students and academic researchers to work on sustainability challenges relating to university business – on and off campus – for example, within supply chains or activities in the local community. Collaborative Living Lab projects can provide answers and guidance for operations and professional services staff, produce real-life learning opportunities for students, and create opportunities for research impact[2]. The scale of Living Lab projects vary from small groups within courses, to dissertations, and even to multi-year academic research. Examples of projects include energy data visualisation to engage building users, a photovoltaic feasibility study, reducing contamination in waste streams, investigating the sustainability of palm oil in supply chains, and studying the effects of increasing freezer temperatures in laboratories.

An increasing number of universities, globally, are embracing the Living Lab approach on campus and in Higher and Further Education sector networks. The Environmental Association for Universities and Colleges and the International Sustainable Campus Network, for example, are working to promote and support the Living Lab approach.

## ENGAGING STAKEHOLDERS

The SRS has not encountered any difficulty over the last few years in terms of finding students interested in working on Living Lab projects. Research commissioned by the SRS in 2015 found that students questioned would like more opportunities for experiential learning in a real-world context[3]. However, some effort has been required in engaging academic and operations colleagues in this approach.

There was an initial challenge of convincing academics that a department based in the Corporate Services Group had legitimacy in terms of initiating and facilitating research projects. By working first with a small number of academics who saw the value of this new approach, others have been encouraged to participate over time. An SRS Academic Network was established in 2014, which now has over 175 members from different disciplines. The network's email list has proven useful for sharing project ideas and funded research opportunities, and finding academics interested in collaborating on particular themes. The SRS has also developed ongoing links with course leaders and university school placement coordinators, to whom Living Lab project ideas are pitched each year, thus allowing students to choose which projects they want to work on.

Regarding operations staff (e.g. people working in the Energy, Procurement, Transport, Finance, Catering, Estates Design and Maintenance, and Waste offices), the SRS has a number of longstanding collaborators, but still needs to continually make the case for how student and academic research can help teams achieve sustainability goals (**Figure 2**). The SRS acts as an intermediary between practitioners and researchers, helping to identify relevant project ideas, and helping stakeholders find successful ways of working together. It also ensures that concise briefing papers are produced when projects are completed, so all staff know what the key findings and recommendations are. Operations staff are also invited to student presentations where relevant.

In order to embed a new way of working within a large organisation such as a university, it is important to also ensure senior 'buy-in' and support. The Living Lab approach has been presented at the University of Edinburgh's Social Responsibility and Sustainability Committee, and the Learning and Teaching Committee. One of the Assistant Principals acts as 'Champion' for Living Labs. This senior support encourages other staff to buy in to the approach, and can potentially unlock any internal funding available for priority projects. While the aforementioned 2015 research found there was little awareness and understanding of the concept among different types of staff, the term Living Lab is now in the university's 2016 Strategic Plan[4].

## CHALLENGES

There are various challenges relating to running Living Lab projects in a university, which appear to be common across other institutions. Firstly, students often want to work on aspects that have been examined before, and can end up making the same recommendations as others have made, if they are not made aware of the context, and what avenues have been explored previously. There can also be a tendency for some operations staff to feel overburdened if they receive too many direct queries from students and academics about their working practices; devoting time to the Living Lab approach is not yet built into operational job descriptions. It can also sometimes be difficult for students to understand why change might take a long time to occur in the university – with new procedures and ideas needing to be approved by relevant committees and then gradually embedded.

▲ **Figure 1. Staff and students visit a recycling facility (© Sarah Ford-Hutchinson).**





▲ **Figure 2. Staff and students discuss social responsibility and sustainability priorities for the future (© Anna Ervinková).**

For researchers, it can be challenging to obtain relevant operational data; it may not be available in a suitable format, or operations staff may be reluctant to share it without fully understanding the researchers' aims. It can also be difficult to identify research questions that are both practically relevant to operations units, and interesting and complex enough to be the focus of (funded) academic research.

There are ongoing challenges relating to how researchers and operations staff work together which reflect the apparent divide between academic and non-academic staff in the university. Staff members may have different objectives, timescales, language, terminologies and communication styles, and both parties are likely to lack time.

## BECOMING MORE STRATEGIC

In light of the above experience and challenges, the SRS is now working on a more strategic approach for the University as a Living Lab. A new online database of projects shows past projects, searchable by theme, with summaries of their findings, recommendations and new project ideas, together with staff contact details for each. This will help prevent the duplication of projects and assist researchers to respond to recommendations made for further research (sometimes building on past projects). The SRS website also now contains a toolkit of guidance for staff and students planning to work on Living Lab projects – providing tips on how to identify appropriate projects, create agreements, work together, and share data and findings. A standard evaluation form is now available for all staff and students working on university-led Living Lab projects, so more accurate data on learning, outcomes and impact can be collated.

In future, the Living Lab approach would benefit from a data governance policy for the university, to clarify how data should be managed and shared, and from the inclusion of a reference to the Living Lab approach in role descriptions and inductions for staff. The SRS is working to collaborate with academics to access further funding for specific Living Lab projects, and is open to collaborating in this area with other institutions. **ES**

**Liz Cooper** is Research and Policy Manager in the University of Edinburgh's Department for Social Responsibility and Sustainability, focusing in particular on supply chains, and the Living Lab approach. She holds an MSc in Business and Community, and has worked in Senegal and India for several years on livelihoods projects.

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# Building the Earthhouse

The winner of our student writing competition, **Christopher Norris**, reflects on his own experience getting hands-on with a sustainable construction project.

In the run-up to the publication of this edition of the environmental SCIENTIST, student members of the IES were asked to submit a short article reflecting on their experiences of Living Labs initiatives during their studies. After receiving a number of high-quality submissions, Christopher's article on the Earthhouse project was chosen as our winner. Living Lab initiatives have great potential to enrich the learning experience of students, as well as the university community and environment more generally. It is important that students' thoughts and experiences are able to inform the continual development of this approach. Christopher's article explores his involvement in a practical, real-world project, and reflects on what he learned.

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During a University of the West of England (UWE) lecture, I was excited to hear that architect Tim Baddeley had built a low-carbon eco-home from construction waste for under £5,000. I was lucky enough to visit the Earthhouse, where I learned about Tim's techniques and helped to build an interior wall.

One of the main innovations is the use of tyres as a roofing material. Tyres are cut and arranged to form a series of interlocking curved tiles (resembling traditional French roofs), creating a surface of alternating ridges and conduit channels, which are extremely sturdy and can transport water for storage or irrigation. The lattice effectively supports grass or sedum roofs with minimal soil, and the tyre grooves capture moisture and stabilise the vegetation, making slopes with an angle greater than 15 degrees possible (**Figure 1**).


© Christopher Norris

▲ **Figure 1. Cut and arranged tyres forming the lattice roof of the Earthhouse (© Christopher Norris).**

There are several economic benefits: rubber naturally biodegrades slowly so the roof's lifetime is measured in centuries; the low soil requirement eliminates the need for costly roof re-enforcement before planting; and used tyres have a negative capital value (up to -£10 each). Cutting the inner steel wire to produce flat tiles is labour-intensive, but tyres can also be turned into resilient housing foundations, used as the basis of a concrete-free floor, or used to make airtight, circular windows. The walls of the Earthhouse are made from straw bales, buffered with a wooden wattle-and-daub pattern, and overlaid with an insulating clay and lime mixture. These walls are resistant to earthquakes and frost-heave due to their low rigidity, and their thermal admittance (ability to absorb and slowly release heat) often equals or exceeds that of conventional brick walls[1,2].

I met Tim Baddeley following a guest lecture he gave at UWE, where I expressed an interest in his techniques. He invited me to attend a building session with a group of other UWE students – a messy, but enjoyable experience! The process involved hurling handfuls of waterlogged clay and lime mixture at the straw-bale underlayer, then evening out the surface by hand. Tim also helped me to create an interior window using a wood-weave bordered with clay (**Figure 2)**; the techniques were easy to learn and proved clearly effective. As I worked, I was surprised to find a live tree built into the home, supporting part of the roof; just one example of Baddeley's radically different approach.

## SUSTAINABLE DEVELOPMENT

Standard construction processes involve high carbon dioxide ($CO_2$) emissions, but these can be mitigated by eliminating the use of cement, and by repurposing wastes from local businesses as construction materials. Upcycling waste materials creates value; whereas most waste are processed at an additional cost to businesses. Salvaging and reusing materials makes resource usage cyclical, thus boosting efficiency and lowering costs.

Researching alternative construction methods can lead to lower energy requirements and material costs, minimise embedded $CO_2$, enhance biodiversity, and improve local air quality. Sedum roofs can counteract the urban heat island effect, filter atmospheric particulate matter, impede storm runoff, and create microclimates, thus preventing urban habitat fragmentation.

Earthhouse provides evidence that these benefits are attainable and affordable. Further research could mitigate problems, and generate wider acceptance of these techniques in the construction industry, contributing to increased resiliency and waste reduction in the line with the 2008 Waste Framework Directive[3].

## INSPIRATION

Earthhouse demonstrated that, through innovation, creativity, and the rediscovery of traditional methods, value can be added to materials typically deemed fit for disposal. By transforming waste materials from costly burdens into the foundations of a project, housing developments can achieve low costs and low environmental impact, without endangering householder safety or comfort. In fact, Earthhouse's insulation outperforms that of conventional housing.

▶ **Figure 2. A wood-weave interior window under construction (© Christopher Norris).**

As an Environmental Science student going into my final year, Tim Baddeley's Earthhouse increased my enthusiasm for DIY sustainability techniques. The project demonstrated that leftover materials from brownfield sites are often valuable enough to justify their re-use, as long as site pollution levels can be reliably and cheaply monitored, and reduced to within safe limits. This inspired me to investigate low-cost, low-toxicity alternatives to land reclamation for my dissertation, where I showed that sunflowers *(Helianthus annuus)* can catalyse the bioavailability and breakdown of polycyclic aromatic hydrocarbons – a toxic organic by-product of coal gasification and waste incinerators – in aluminium-rich soils, assisting the remediation process which prepares brownfield sites for residential development.

'Value from waste' is a mindset shift with the potential to save developers money, safeguard the environment, and inspire new sustainable construction efforts in the United Kingdom and worldwide. Personally, I am thrilled to have helped with this project firsthand and look forward to seeing further experimentation in the construction industry, and the incorporation of Earthhouse's techniques into residential and industrial developments. ES

**Christopher Norris** is a 1st-class Environmental Science graduate from the University of the West of England. He completed a placement year at the Engineering & Physical Sciences Research Council (EPSRC), and currently handles UK data for the United Nations' Sustainable Development Goals at the Office for National Statistics (ONS).

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# Navigating the labyrinthine: Leadership and Living Labs

**Janet Haddock-Fraser** and **Peter Rands** analyse how the Living Labs approach in universities can bring about a positive and more effective leadership style when integrating sustainability into projects that have societal benefits.

How universities have delivered on their mandate has differed through time. The last century has seen the role of universities, and attitudes to education in society, move from the 'cloisters' and 'ivory towers' to the connected, business-engaged and societally-bound universities of the present day. They have not reached an endpoint in evolution, and they need to continue to adjust their scope, remit and priorities in order to provide a sustainable future for the world's population. Suggestions for how they should do this are encapsulated by Barnett in the Oxford Review of Education[1] where his 'ecological university' is defined as one that takes seriously the world's interconnectedness and the university's interconnectedness with the world. The purpose of this is to enable: (i) students as global citizens; (ii) care and concern for the world; and (iii) students and faculty to understand their own possibilities in the world and towards the world. This ambitious and heartfelt call seeks a system where universities are there to work in society for the good of humanity and to operate with sustainability in their heart.

Most universities engage in some aspect of sustainability already. As academic institutions, there is much debate about the scope of its definition (i.e. environmental, societal, economic and in isolation or as a collective), the extent to which a university should 'impose' its values about sustainability on staff and students, and the extent to which it is implemented within core business processes. Developing and implementing sustainability solutions offers substantial challenges, such as should it become integrated into campus operations through student engagement and formally through curricula and teaching? More widely, how should it impact on external facing activities, particularly what and how it is researched, and how is this shared within wider society? Lastly, to what extent should consideration be given as to how sustainability fits with university values, and how can it be measured, or should it develop organically at faculty, individual advocate and issue-specific level?

The use of the Living Labs approach offers universities a cornerstone to achieve societally-relevant, real-world

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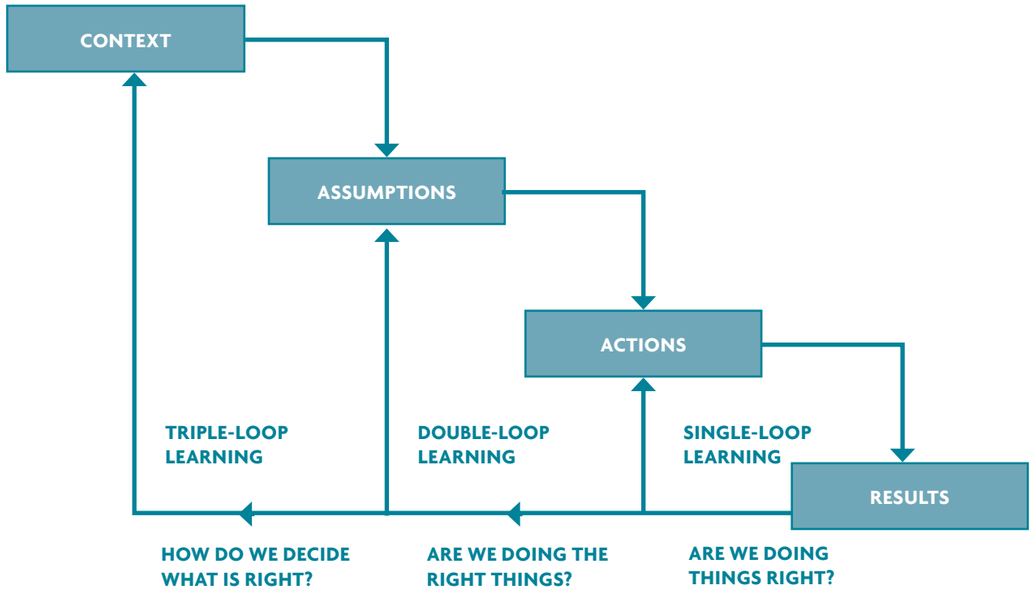



▲ **Figure 1. Triple loop learning (adapted from "Forum for the Future[2]).**

sustainability solutions. It embraces the concept of the interconnected or ecological university, as it seeks to bring together disparate stakeholder groups (from within and outside of the university) for the co-creation of sustainability solutions, whilst still respecting the stance and motives of each. However, for a Living Lab to be successful, it requires the right sort of leadership; the labyrinthine dynamic of multiple stakeholder engagement, which seeks sustainable solutions for university and society, is unlikely to emerge without it.

## IS THERE A 'RIGHT SORT' OF LEADERSHIP?

Leadership involves influencing others towards a common goal. As such, leaders need followers and purpose. Theories on what makes a great leader have developed in line with social norms over time. Early thoughts from the 1920s which suggest 'great man' traits such as the ability to impose a leader's will on others[3] are, thankfully, rare now. Instead, debate fluxes between whether a leader's traits (inherent personality) or their ability to work successfully with, and adapt to, the situation and context they are working in, is more relevant. These are termed 'situational leadership models' and they recognise that successful leadership requires a fortuitous mix of leader's traits being sympathetic to, or aligned with, the situation they are operating in, and an understanding of the role followers take[4,5]. It is useful to explore two extremes to illustrate this. An accident and emergency consultant in a hospital is likely to require command-and-control and task-orientated approaches to leadership because speedy decision-making and recognition of a single authority may be the difference between life and death. In contrast, an academic leader is more likely to need to embrace discussion and debate, and has to listen to the dissenting voice before decisions are made. Consequently, they also need lots of patience.

The type of power held by the leader can influence their most appropriate way of operating. For example, a leader with 'legitimate' power (i.e. authority held through a post such as a Head of Department) may be able to operate through command-and-control means more readily than a leader in a facilitative role such as that many sustainability leaders in universities find themselves in. This is termed 'referent' power, where influence comes through persuasion, charisma or belief in the work of the leader by their followers.

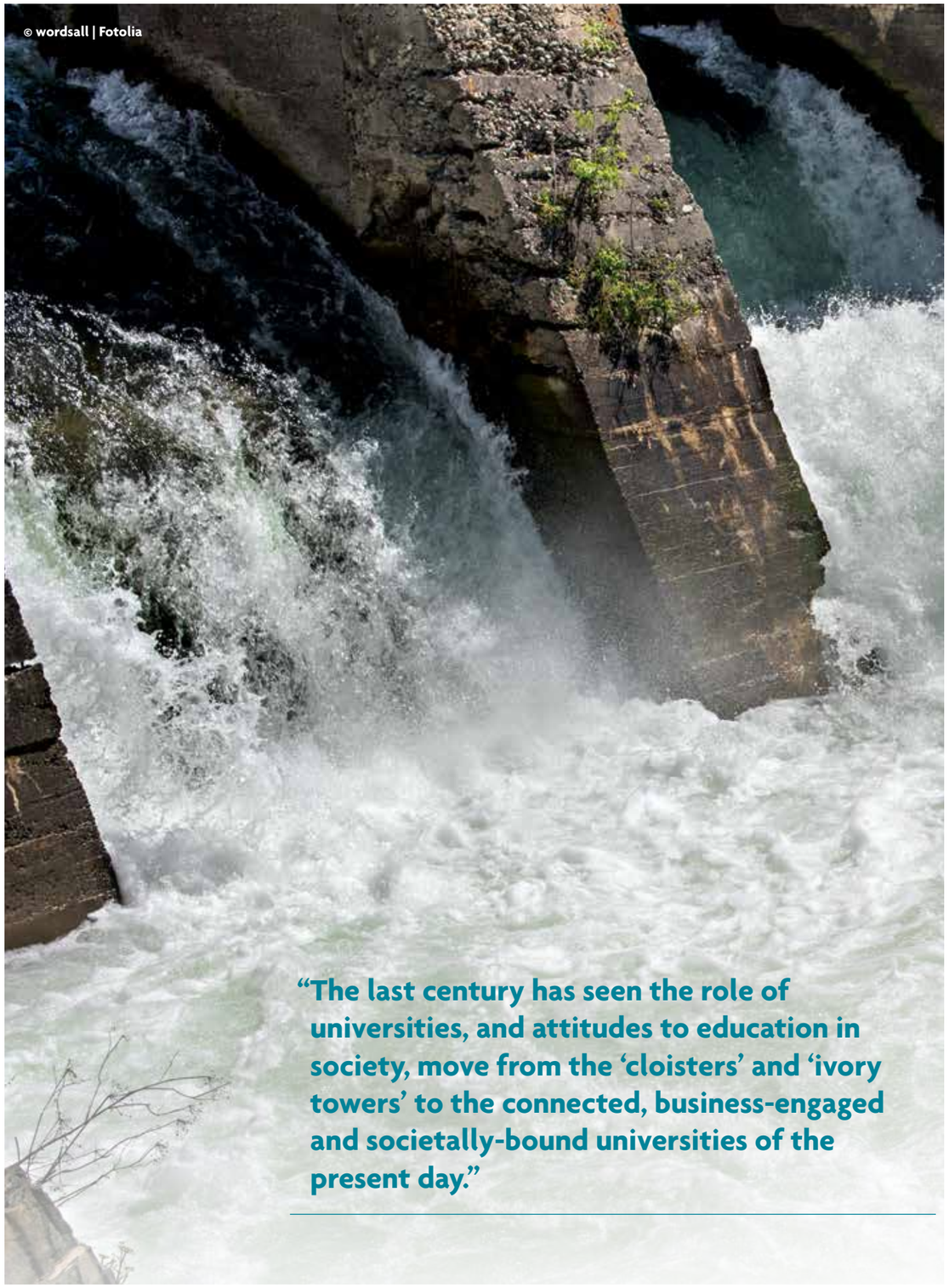
## LEADERSHIP FOR SUSTAINABILITY

In line with general leadership theory, sustainability leadership considers both individual attributes and the situation the leader is working in. Within these, key attributes specific to successful sustainability leadership emerge, which are summarised by Shriberg[6] as:

- Systems intelligence and the ability to analyse complex decisions that cross traditional boundaries.
- Visioning that requires balancing short-term institutional goals with longer-term thinking.







- Humility that uses an inclusive and diverse approach.
- Embracing and capitalising on change, and working through a multitude of factors and uncertainty.
- Orientation towards enlightened self-interest, where long-term thinking about sustainability can be balanced with self-interest in decision making.

These attributes complement other leadership models that resonate with sustainability leadership, and particularly with: (i) transformational leadership; and (ii) deep systems leadership models. The first of these, transformational leadership, is an approach supporting tangible action and change in an organisation whilst transforming values, attitudes and behaviours of followers. This could be aligned with the idea of 'triple loop learning' (see **Figure 1**) which is where the fullness and deepness of issues and dilemmas faced, and the complex interactions between factors, is understood[7] (and is more succinctly described as 'collective mindfulness'). Within universities, a transformational leadership approach offers much at one level, with sustainability leaders operating as inspiring, motivated role models of sustainability. However, it can stall when it clashes with the existing hierarchical structures in universities, which includes their governance and decision-making processes[8].

The deep systems leadership approach focuses on the scope of factors relevant to sustainability. Its style originates with systems based approaches. These have been criticised for being task-orientated and mechanistic[9], but have subsequently developed to encapsulate the complexity and interdependence needed for decision making in sustainability, as well as the fact that some decisions need to be made in the absence of certainty[10]. This approach calls for leadership to have systems intelligence (as noted by Shriberg[5] earlier), and to understand the complex webs of the organisational ecosystem and its hinterland, within the remit of economic, social and environmental sustainability. For this to be successful, it is recognised that leaders need to operate in non-hierarchical ways, bring teams and stakeholders together in a facilitative manner, and transcend organisational boundaries through referent power.

## LEADERSHIP FOR LIVING LABS

The notion of Living Labs offers the bridge and mechanism for collaboration and creativity towards sustainable solutions for real-world challenges. For universities, they have been defined, through work of the Environmental Association of Universities and Colleges in the UK and Ireland, as:

*"Where real-world sustainability challenges are formally addressed in stakeholder partnerships [this] encourages co-creation and co-implementation of transformations through transdisciplinary efforts, over a series of learning loops, to sustainably develop a geographically-bounded test-bed"*[11].





Living Labs provide the opportunity to legitimise a much needed new way of thinking about sustainability in universities. Although used in a different context, the challenge from Einstein that "A new type of thinking is essential if mankind is to survive" is as relevant today as it was in 1946[12]. The premise of the Living Lab model can provide the means to achieve this by multi-stakeholder collaboration when working on real-world problems.

Reviewing the research undertaken on university Living Labs by Waheed[11] provides some guidance on the range of activities a 'Leadership Lab' coordinator may need to undertake for a successful Living Lab to run. These activities include project management, establishing, training and communicating with participants and stakeholders, managing and expanding the Living Lab and its projects, and building buy-in to the approach amongst a wider audience.

In terms of delivering against these tasks, it is helpful to look more closely at the principles and approach used within Living Labs. From these, the following emerge as relevant leadership qualities:

1. formal (organisational) systems;
2. multi-stakeholder engagement;
3. a holistic and all-embracing definition of sustainability;
4. transdisciplinary approaches;
5. co-creation and co-implementation;
6. non-hierarchical and equal participation by all stakeholders;
7. loop learning.

These speak to many of the core concepts of leadership within sustainability. The need for multi-stakeholder, holistic, transdisciplinary approaches and the ability to span the different vocabularies, paradigms and enquiry approaches of this, resonate with deep systems leadership approaches. The non-hierarchical, co-creation and co-implementation approaches, along with (triple) loop learning concur with transformational leadership models. Interestingly, the use of these approaches enables sustainability solutions to move forward through well considered nuanced solutions, where there are high levels of buy-in from participants (followers) at a deep transformational level. This provides the added advantage of skills development, and a deep-seated belief in solutions that enables participants' involvement in further initiatives, with opportunities to spread their knowledge.

## THE BEST APPROACH?

Universities have a powerful opportunity to lead on pursuing wide-ranging sustainable solutions for society, the environment and the economy. They bring new knowledge, new thinking and the opportunity to work in new ways with stakeholders outside of their institutions; that is to be 'for and of society'. The Living Labs approach provides a helpful approach to structuring these engagements for the benefit of holistic decision making in a co-created way. The approach requires good leadership for it to be successful, but traditional notions of leadership through position (or legitimate) power, and command-and-control systems endanger co-creativity, holism and true transdisciplinary engagement. However, leadership models exist which speak to the situation and circumstances offered by Living Labs, through transformational and deep systems leadership approaches. These bring the requisite levels of engagement at a transdisciplinary level, with labyrinthine complexity, and in tandem with deep engagement; all approaches that bring transformation of motives, beliefs and values, in addition to behaviour. ES

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CASE STUDY

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# Natural flood management: An integrated approach in a rural-urban catchment

**Josh Wells** and **Jillian Labadz** reflect on the impact a new natural flood management scheme has had on a tributary in Southwell, Nottinghamshire.

Flood risk management is an important issue in the UK and globally, so more sustainable methods to reduce flood risk are now being sought. Within the UK, a shift in focus is occurring, which is steering emphasis away from reliance on hard engineered defences and 'taming' the river. We are moving towards softer approaches, such as improving community resilience and more integrated flood risk management. Natural flood management (NFM) is part of this integrated approach and aims to slow water flow and capture runoff within the upper parts of a river catchment. It brings promise of potential benefits beyond flood risk management, such as habitat enhancement, sediment capture and pollution reduction.

This all sounds very positive, but the evidence base to support the widespread application of NFM as an approach to flood risk reduction is still in its infancy. There have been some widely publicised and very successful examples, including those at Belford in Northumbria[1] and Pickering in Yorkshire[2], but too often elsewhere the works have been completed on an opportunistic basis, with limited funding, and without scientific monitoring to allow assessment of any changes in river behaviour that have been achieved. There is increasing enthusiasm for NFM from statutory bodies, such as the Environment Agency and the Department for Environment, Food and Rural Affairs (Defra), and it has also received strong support from the Scottish Environment Protection Agency (SEPA). In July 2017, Defra announced its plans for the funding of £15 million towards a number of large new NFM projects[3], but there is still limited scientific evidence surrounding the nature and scale of effectiveness of NFM. Wider support for public funding of such schemes is also variable and complex social and economic barriers to their practical implementation continue to exist.

Southwell in Nottinghamshire has a history of repeated flooding, including the summer of 2007 when floods were widespread in England, and most recently in July 2013, when it was affected by an intense summer convective storm; almost 100 mm of rain fell in a single hour following a period of exceptionally hot weather[4]. Many people in the town found their properties flooded by a mixture of fluvial and surface water flooding. As a result of the 2013 event, a community based local flood action group, the Southwell Flood Forum, was established which aimed to not only increase community resilience, but to work in partnership with the Lead Local Flood Authority and have in an input into future flood risk management planning for the town. Therefore, Southwell now offers an ideal opportunity to implement NFM interventions within a 'Living Lab' setting whilst working with a range of stakeholders.

The NFM project in Southwell is being conducted by Nottingham Trent University on tributaries of a river that flows through the town, known as the Potwell Dyke. Further upstream, these tributaries also flow through the rural Brackenhurst Campus of the University, which includes a 200 ha farm with a mixture of arable crops including wheat and oilseed rape. The study is taking an interdisciplinary approach to researching the barriers to wider NFM implementation, including whether stakeholder engagement can increase overall project success.

## STORING AND SLOWING WATER UPSTREAM

Environmental monitoring was established in 2013 (rainfall and stream water levels), and an experimental NFM scheme was implemented on two small sub-catchments of the Potwell Dyke in 2016. This will allow for a comparison, for selected flow events, of changes to the way water levels and stream discharge behave over time (the hydrograph).

The NFM interventions included the restoration of a previously straightened reach of stream on the Springfield Dumble. This includes an area of lowered floodplain, which creates a wider water storage area connected to the stream when flows are high. **Figure 1** shows the ditch flowing from the bottom of the picture towards the woodland (where it becomes known as Springfield Dumble) and on into the town. The original stream channel pattern was obtained from historic Ordnance Survey maps and an aerial photograph taken by the Royal Air Force in 1947, and was set out on the ground using a differential global positioning system survey. In keeping with the theme of sustainability, soil excavated from the stream restoration was used to create five earth bunds (raised banks) in corners of the farm fields. These are designed to hold surface water runoff for up to 24 hours and then for the water to be released slowly. Reuse of the soil on-site helped to reduce costs of the scheme and avoided paperwork involved in moving waste soil off-site. In addition, 13 large woody debris (LWD) dams were installed within the stream channels. The LWD dams aim to hold back water behind them and in some cases also to force water out of the channel and onto the floodplain, where the ground surface is rougher and so the flow can be slowed even further. Data are now being collected to assess whether the NFM scheme has had a measurable impact on the flood risk for Southwell.

Preliminary findings have been exciting. During a heavy rainfall event in Autumn 2016, a comparison with the

▲ **Figure 1. Aerial image of Southwell and the ditch feeding into Springfield Dumble before stream restoration in the summer of 2016 (© Dr Steven Godby).**

▲ **Figure 2 Aerial image of the newly restored Springfield Dumble stream channel, and a constructed earth bund storing field surface water runoff following Storm Angus in November 2016 (© Dr Steven Godby).**

▲ **Figure 3. Large woody debris dam in Springfield Dumble slowing and storing water flow during Storm Angus on the 21st November 2016 (© Josh Wells).**

stream response from a similar event before intervention showed a reduction in stream water level on one of the tributaries which had been subject to NFM. For another tributary, this was not so clearly observed. These findings are very preliminary, as bund construction was still taking place as the event hit. As a result, not all the potential additional water storage was available. An aerial image captured shortly after the rainfall event (**Figure 2**) demonstrates that water was stored within the constructed bund and that the additional water storage area connected to the stream became active. Thus, some evidence of success was recorded. Images taken of the large woody debris dam holding back water (**Figure 3**) also indicated some success.

## BARRIERS TO NATURAL FLOOD MANAGEMENT UPTAKE

This experimental scheme has also allowed for a social case study to be developed, giving deeper insight into the barriers to NFM uptake. Questionnaires were sent to the local residents before NFM implementation, to explore both their knowledge of NFM and their attitudes towards it. The results suggested that there is support for NFM within their catchment, but public knowledge of NFM was limited. Many respondents indicated they would like more research on the impacts of NFM on flood risk.

Interviews with local landowners and practitioners of flood risk management identified further barriers to uptake. Landowners expressed that significant barriers for them were economic constraints on the farm business. NFM measures require spatial opportunity in the upper catchment area, which are often areas of valuable farmland. The interventions can cause land to be taken out of production, leading to loss of crops and financial implications for long term maintenance. Landowners stated that the farm is first and foremost a business so, without proper compensation, NFM would not be in their best interests. Additionally, landowners said they would like to see more evidence of a significant benefit in terms of reducing flood risk for the downstream communities, before they would be willing to install such measures.

Practitioners of flood risk management also cited lack of evidence as a barrier. Under current UK flood risk management policy, a cost-benefit ratio needs to be calculated in order to demonstrate the value of a flood risk management measure. However, due to the lack of scientific evidence, this is currently difficult to prove in the case of NFM. Consequently, funding has been limited until recently. The lack of hydrological monitoring of most current NFM projects has also hindered the closure of this evidence gap and it is vital that new projects have sound monitoring plans based on scientific principles of experimental design, with data collected both before and after interventions, and monitoring carried out upstream and downstream. Many previous projects did not have funding for scientific monitoring, so data collection before and after NFM implementation has been overlooked and opportunities have been missed. With the new Defra funded schemes coming online in 2017 onwards, there are important scientific opportunities which need to be grasped in order to address this problem.

Practitioners also related back to a concern of the landowners, stating that a current lack of funding for long term maintenance hinders the uptake of NFM. Without proper guidelines on how best to maintain these structures, and with a lack of funding for institutions to do so, NFM will be overlooked as a valid flood risk management measure. Finally, they stated that without proper stakeholder engagement, NFM projects can fail at the first hurdle as support for them may be lacking, and transparency between different interest groups is not achieved.

## PARTNERSHIP WORKING

This Living Lab project has recognised that stakeholder engagement is becoming increasingly important within flood risk management. As a result, transparency with stakeholders has been key throughout the research. Members of the Southwell Flood Forum have been involved within some of the design stages of the project in an effort to increase acceptance, and the value of the results to the local community. Public talks and site demonstrations for interested groups have been provided within the town and site visits have allowed local landowners and managers to see the research, ask questions and make comments. All of these activities have raised the profile of the research, contributed to increasing knowledge of NFM and given the community a sense of ownership of the project. Towards the end of the project, views will be assessed to see if the methods above have increased its overall success. Stakeholder engagement will continue, as it is central to both the project and the values of the researchers. It has been key within the project to recognise that, for any type of flood risk management to be truly sustainable, it needs to involve all those with an interest. ES

**Acknowledgements**

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**Josh Wells** is currently a PhD student at Nottingham Trent University, undertaking research on the impact of natural flood management on flood risk and investigating barriers to its current uptake. His previous studies include MSc Environmental Management at the University of Nottingham and BSc (Hons) Geography at Nottingham Trent University.

**Dr Jillian Labadz** is a hydrologist specialising in stream runoff production from rural catchments, including peatlands managed for habitat conservation (upland and lowland) and natural flood management. She is a Postgraduate Research Tutor and teaches undergraduate and PhD students in the School of Animal, Rural and Environmental Sciences at Nottingham Trent University.

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TECHNICAL

# Novel research methods supporting advanced waste treatment technologies within a circular economy

**Edward Randviir** describes a practical application of the Living Lab approach to an investigation into the failure of a waste treatment tank.

One of the principles of the circular economy is to ensure that maximum use is obtained from the materials we consume and that the use of virgin materials is minimised; it is a philosophy that underpins European Union policy instruments[1,2,3]. As a result of these policies, a large burden has been placed upon the waste management sector in the UK, as they have been identified as one of the major links to the future of a circular economy. One response to such instruments at a local authority level, is to implement advanced waste treatment technologies, such as anaerobic digestion, in-vessel composting or 'Energy from Waste' facilities so as to extract maximum value from waste, minimise waste to landfill, reduce climate change impacts, recycle more materials, and create new jobs. This has required the upgrading of existing infrastructure, and the design and construction of new infrastructure. An unforeseen consequence of these novel operational systems has been the need to ensure the ongoing health and longevity of the technologies.

Technologies and infrastructure that treat large amounts of waste, such as anaerobic digestion plants, can be subject to physically and chemically aggressive conditions that are difficult to control. The consequences of this are failures, such as the erosion of concrete, corrosion of steel, the degradation of protectors and coatings, the pitting of stainless steel and blockages to pipework. Downtime of treatment processes not only increases running and maintenance costs, but also limits

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the ability to maximise the reuse of waste and increases the diversion of waste to landfill. This is detrimental to the fundamental principles of the circular economy. It is therefore imperative for industry to invest in resources to tackle such issues and to plan for downtime arising from operational failure.

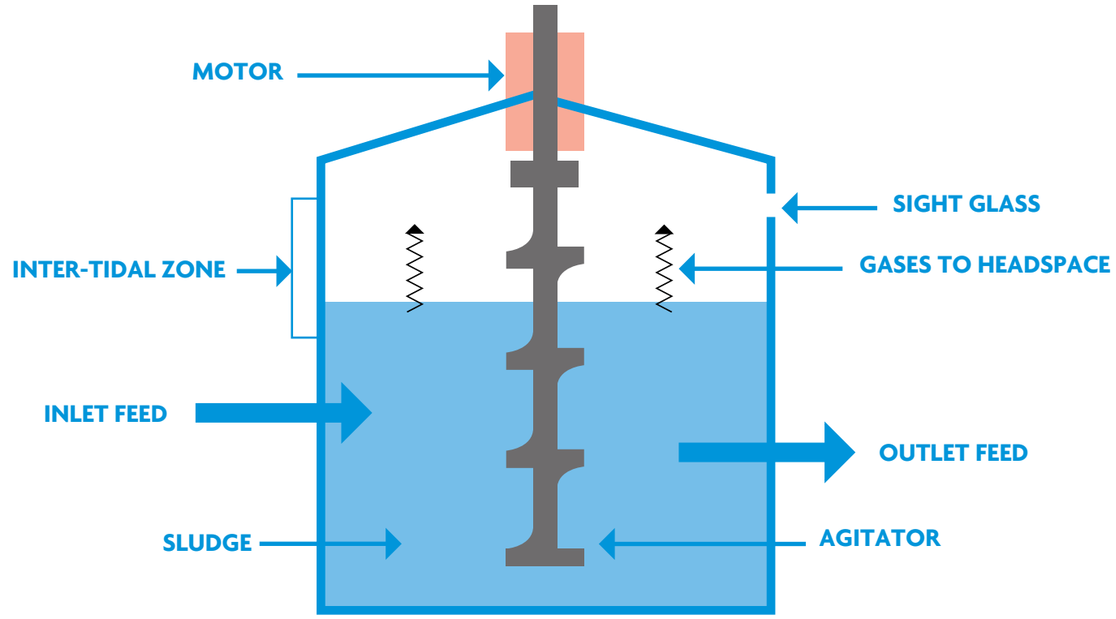
The Waste 2 Resource Innovation Network (W2RIN) at Manchester Metropolitan University was established to address exactly such challenges. The core team, within the Faculty of Science and Engineering, comprises staff with a wide variety of expertise including (but not limited to) chemical and biological technology, policy interpretation and legal compliance, waste collection, contract procurement and management, transport logistic planning, waste treatment feedstocks and material markets, engagement techniques and behavioural change. We believe a full holistic approach is required to address the range of issues that occur within advanced waste treatment. The combination of this expertise allows for a user-centric approach towards addressing technical (and other) challenges faced by the waste management industry through liaison with plant operators, and middle and senior management. This approach effectively uses waste treatment processes as a 'Living Lab' that allows academic research methods to be implemented in innovative ways. We have contributed our expertise to understanding several problems encountered within the waste industry, such as anaerobic digestion and in-vessel composting corrosion, the identification of odour control system failures, the recycling of new wastes arising from advanced processing and the optimisation of sludge management processes.

## ASSESSMENT & DIAGNOSIS OF HYDROLYSIS TANK FAILURE

An example of this type of approach is provided by an investigation into the failure of a hydrolysis tank at a municipal solid waste treatment plant. The tank investigated has a holding capacity of 4,000,000 litres of organic sludge derived from municipal solid waste, and is responsible for treating approximately 250,000 litres of sludge per day. Waste sludge is chemically broken down into digestible material for the purpose of methane production, which is then used as a gaseous fuel in a combined heat and power generator, producing electricity to meet the needs of the entire waste treatment site. The failure of the hydrolysis tank meant that the site was unable to process the organic waste, so less waste was recovered and more waste had to be transported for incineration or diverted to landfill; ultimately less energy was then generated by the combined heat and power engine.

A failure in the integrity of the hydrolysis tank was discovered when an operative found an orange residue dripping from its outer walls. Upon closer inspection, the operative found that the tank was suffering from irreparable corrosion damage from the inside, despite

TECHNICAL




▲ **Figure 1. Not-to-scale diagram of the hydrolysis tank (© Manchester Metropolitan University).**

the tank being lined with a protective epoxy coating. The tank had to be immediately drained and supported with scaffolding to stabilise the structure, thereby incurring significant operational and financial cost. An inquest then convened to determine the causative mechanisms of the corrosion. It was at this stage that W2RIN were brought in to provide expert advice, based upon a scientific evaluation of the probable causes of the corrosion, to enable the tank and the process to be redesigned and rebuilt.

## METHODS EMPLOYED

The approach adopted by W2RIN was multi-faceted in nature. Firstly, a visual assessment was completed to determine the nature of the tank corrosion and to identify any patterns in the corrosion profile. It was found that the corrosion was almost exclusive to the headspace region of the tank, known as the 'intertidal zone' (see **Figure 1**), which is where the sludge surface line inside the tank rises and falls. Within this narrow region there were several areas that had completely corroded, implying that something was occurring within this region of the tank that was either occurring more rapidly than elsewhere in the tank or was not occurring at all in other parts.

Secondly, sample scrapings were taken from the tank walls in the affected region for forensic scrutiny in the laboratory using elemental mapping techniques and DNA profiling. Although sulphur does naturally occur in waste materials and is responsible for its many odours, concentrations do not normally exceed 2 per cent by weight. In the headspace, the sulphur content was in excess of 30 per cent by weight. A bespoke DNA profiling method designed for this study identified a sulphur bacteria species (*Acidithiobacillus thiooxidans*) that, in using the sludge as a feedstock, was producing this sulphurous environment. Using these techniques, a picture of the chemical and biological environment in the headspace was formed and found to be significantly different to non-corroded regions of the tank.

Finally, to ascertain how the bacterium was penetrating the epoxy lining (and thus leading to steel corrosion),

TECHNICAL

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acidity tests, degradation experiments, and bespoke computer modelling software were used. Acidity tests in the intertidal zone found a very low pH of 1.5, indicating an environment over 10,000 times more acidic than expected in the tank (normally a pH range of 5.5–7.0 is expected). *Acidithiobacillus thiooxidans*, the dominant species found in the intertidal zone, is known to produce a highly acidic environment by releasing sulphuric acid as a metabolic by-product. Steel samples coated with the epoxy lining and then treated with sulphuric acid showed enhanced coating degradation in the presence of the acid. This confirmed information implied by the coating technical datasheet that sulphuric acid would penetrate the epoxy lining within 12 months if left unchecked.

## DISSEMINATION

All experimental data was collated and presented to the client. Following subsequent discussions with various stakeholders, including the manufacturer of the tank, it was concluded by the tank managers that the hydrolysis process itself was responsible for the formation of the bacterial communities, and the current epoxy lining was not fit for purpose. Our client stated:

*"We have been working closely with W2RIN for approximately 3 years and they have been a huge benefit to us on many process projects. We had been experiencing corrosion issues on the hydrolysis tanks that are a part of the anaerobic digestion facilities located in Greater Manchester. We contacted W2RIN and asked for their help in understanding the chemical attack that was occurring in the tanks. Dr Edward Randviir visited both anaerobic digestion facilities and commenced a round of sampling from several areas of the tank. Once the samples had been analysed, they produced a report and presented their findings to all parties involved. The investigation work enabled us to understand the root cause of the problem and make necessary recommendations to the contracting company. We look forward to continuing our close working relationship with W2RIN for many more years to come".*

W2RIN used a variety of scientific research methods to successfully provide valuable information for the redesign of the process and recommended a rebuild of the existing hydrolysis tank. This project provides an example of where modern bespoke laboratory based research methods can support the principles of the waste hierarchy, and help drive the design of new technologies and infrastructure required to support the journey towards a circular economy. The combination of research methods and scientific thinking, typically unavailable to most waste plant managers, allowed for a quicker resolution to the issue so time could be spent more productively on redesigning the process. It also resolved the problem at source, rather than simply delivering a short-term repair. This Living Labs approach has proven to be successful across several different projects within the waste management industry and could be applied to several other industries too.

The move towards a circular economy will require the development of new, sometimes untried and tested technologies and infrastructure. This brings with it new commWercial, legal and operational risks. The economic burden of landfill cost, coupled with the EU policy tools, has made it imperative that the ongoing health of advanced treatment plants are regularly monitored. The work of the W2RIN at Manchester Metropolitan University has demonstrated that, with the appropriate expertise and instrumentation, academia plays a niche role in assessing operational design and providing solutions to prevent costly down time of advanced waste treatment technologies. ES

**Acknowledgements**

For further information regarding W2RIN please contact Amanda Reid via: a.reid@mmu.ac.uk.

**Dr Edward Randviir** is an applied chemist at Manchester Metropolitan University. His research interest is the use of chemical technology to recycle non-virgin materials into new materials for energy and chemical sensor applications. He has authored 21 academic publications and has consulted on several chemical technology issues within Greater Manchester on behalf of the Waste 2 Resource Innovation Network, Manchester Metropolitan University.

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# Taking responsibility for carbon emissions – The evolution of a Carbon Literacy Living Lab

**Rachel Dunk, Jane Mörk, Jonathan Davies, Jenny Davidson, Christopher Paling, John Hindley, Sophie Leigh** and **Helena Tinker** discuss the impact that the Carbon Literacy Project has had on students and staff at Manchester Metropolitan University.


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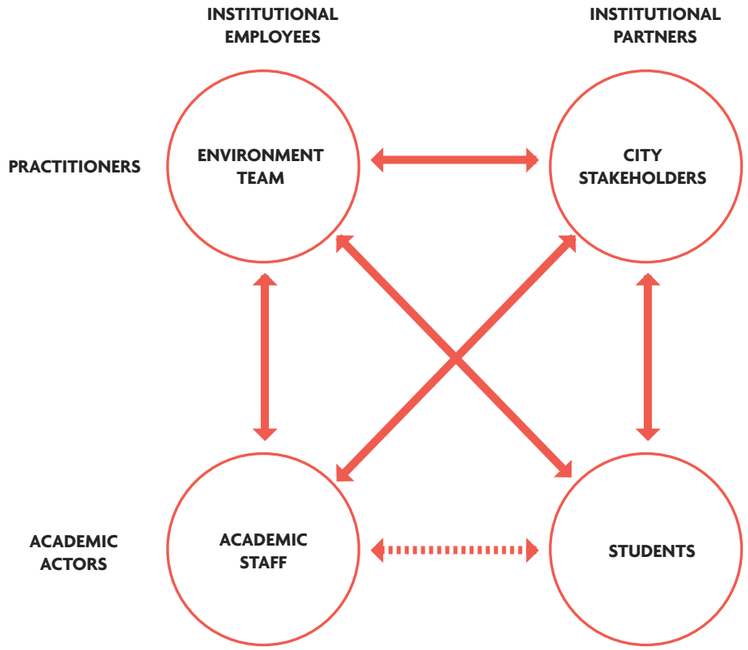
CASE STUDY

Climate change is recognised as one of the major sustainability challenges facing humankind, where to limit the global temperature increase to 2 °C (the upper limit set by the United Nations Framework Convention on Climate Change Paris Agreement[1]) will require rapid and substantial reductions in greenhouse gas emissions (hereafter referred to as carbon emissions). While taking action on climate change is only one aspect of the broader sustainable development agenda, climate and sustainability are intrinsically linked, where the reduction of carbon emissions is of critical importance to sustainable development.

Higher Education Institutions (HEIs) have a key role to play in facilitating the transition to a more sustainable low carbon society, not only through embedding best practice into their own operations, but also through their role as educators, researchers, and community leaders. One critical component of the HEI response to sustainability challenges is 'education for sustainable development', or ESD, an interdisciplinary approach to teaching and learning that encourages students to consider concepts such as environmental stewardship, social justice, and global citizenship, and how they relate to their private and professional lives.

Promoting global citizenship is a key aspect of ESD, where it is important that students recognise their own role in the global community, and have the skills and global perspective necessary to find innovative solutions to complex problems. In response, HEIs are engaging with the internationalisation agenda to provide their students with a global learning experience. While internationalisation is a broad concept that encompasses many activities, student mobility is the most visible aspect, where two core strategies adopted by the UK Higher Education sector are the recruitment of international students and the provision of 'study abroad' schemes. While these activities are financially beneficial for HEIs and provide ESD benefits such as promoting global citizenship, there are also significant carbon consequences due to the associated emissions from air travel. Thus, while there are synergies, there are also conflicting priorities with regard to the UK Higher Education sector's internationalisation and sustainability agendas.

However, while the Higher Education Funding Council for England (HEFCE) acknowledges this conflict within its sustainable development strategy[2], it does not make any recommendations or offer any solutions to resolve it: "Over the last 10 years there has been an increasing recognition of the need to educate our students to become 'global graduates'. Often this has meant providing UK students with opportunities to travel overseas to study at partner institutions, conduct research, or contribute through voluntary work to community development in another




▲ **Figure 1. The 'basket of relationships' between stakeholder groups, alongside the 'basket of principles' (Box 1), that inform the Carbon Literacy Living Lab at Manchester Met.**

country. Similarly, international students, who bring so much to life on UK campuses, have to travel in order to study here. But air travel, in particular, has a carbon cost associated with it"[2].

In this paper, we present an overview of the novel institutional response to this conflict at Manchester Metropolitan University (Manchester Met), a response that evolved from a collaboration between the Environment Team and academics into a fully-fledged 'Carbon Literacy Living Lab' that actively engages students with a societal response to climate change. We use the Environmental Association for Universities and Colleges' Living Lab model[3] to describe the development of the project to date and outline intended future activities, highlighting the relationships between and within the four main stakeholder groups of professional staff, academics, students and external actors, and the principles that shaped the approach and activities (**Figure 1**).

## PROJECT INCEPTION

Manchester Met places a strong importance on environmental sustainability, where the initial impetus for this project arose from an early recognition of the conflict between the carbon management and internationalisation agendas, and the desire to develop

**BOX 1: THE BASKET OF PRINCIPLES**

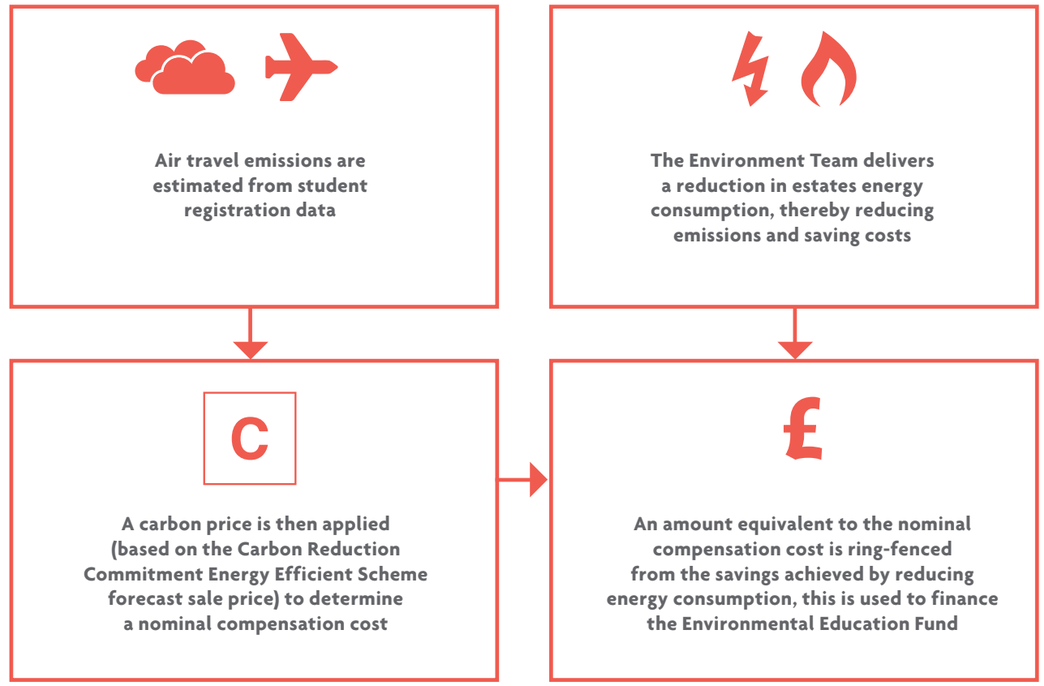
- Real Sustainability Challenge
- Formal Participation
- Stakeholder Partnerships
- Co-creation & Co-Implementation
- Transdisciplinarity
- Geographically Bounded

an appropriate institutional response. This led to a collaboration between the Environment Team and academic researchers to evaluate the emissions arising from international student air travel[4] and to explore a range of potential compensatory actions. This work included co-funding a PhD research student[5] and ultimately led to the development and implementation of an internal mechanism to finance an 'Environmental Education Fund' or EEF (**Figure 2**).

In determining the compensation approach, a number of options were considered, including investment in on-site emission reduction projects, purchase of certified carbon offsets and educational initiatives. The first








▲ **Figure 2. Mechanism for financing the Environmental Education Fund.**

option was rejected as Manchester Met already had a strong commitment to reducing carbon emissions, with a stretch target to reduce emissions from operational energy use by 50 per cent below 2005 levels, by 2020. Thus, while it would present the opportunity to engage students in on-site initiatives, any investment in internal projects would not have generated 'new' emissions reductions over and above those the university was already committed to making. Purchase of high quality certified offsets would avoid this issue of double counting and would also enable the university to formally report that the carbon costs of students' flights had been compensated for in their carbon account. However, this option would be purely transactional, bypassing the opportunity to engage university members and wider stakeholders with the climate change challenge. For these reasons, the preferred compensation approach was to establish an EEF, with the principal aim of actively engaging the student body (and through them, the wider community) so as to encourage and support them to take action on climate change

## THE REMIT OF THE EEF – THE MANCHESTER CONTEXT

The remit of the EEF was determined with a strong reference to the Manchester context, specifically the citywide climate change action plan – Manchester: A Certain Future (MACF)[6].

Published in 2009, MACF was developed by a wide range of city stakeholders and had two headline objectives: to reduce Manchester's emissions by 41 per cent below 2005 levels (by 2020), and to bring about a low carbon culture change through embedding low carbon thinking into the lifestyles and operations of the city. The 41 per cent target reflected a best estimate of Manchester's fair contribution to meeting the UK Climate Change Act targets[7], and has since been extended to a stated ambition to become a 'zero carbon city' by 2050. The joint focus on culture change reflected the understanding that the deep emissions cuts required to limit or prevent dangerous climate change are technologically, politically, and culturally challenging. For citizens to understand the scale of the problem and feel empowered to take action was therefore viewed as a critical issue, both to promote behavioural change and to increase the acceptability of climate mitigation initiatives.

The Carbon Literacy Project (CLP)[8] was established in 2012 as the key delivery vehicle for promoting low carbon culture change. Recognised in 2015 at the 21st Conference of the Parties to the United Nations Framework Convention on Climate Change (COP21, where the outcome was the Paris Agreement[1]) as one of 100 'Transformative Action Projects' from around the world, the CLP is an education initiative that aims

**BOX 2: THE CARBON LITERACY STANDARD[8]**

**Knowledge**

Carbon Literacy training provides students with a knowledge of the basics of climate change science and what we can do to reduce our impacts.

**Values**

This is achieved by instilling a number of values:

- The actions of individuals can and does make a difference.
- We need to work with others to create change.
- Overall, the outcome of the changes we need to see can lead to a better world and a better way of life.
- Equity and fairness.

**Action**

By the end of the training two actions will have been created; one individual and one group.

**Learning and training**

A number of different teaching methods are utilised including 'local' social learning, delivery of training by peers, and group enquiry. The course lasts the equivalent of one full day, but can be delivered via multiple, shorter sessions.





to provide everyone that lives, works and studies in Manchester with access to carbon literacy training. Acting as a standards body, the CLP accredits third party training courses and checks that trainees have met the requirements to be certified 'Carbon Literate' (see **Box 2**). Manchester Met has actively supported the CLP from its inception, being one of the first organisations to pilot carbon literacy training to its students, and offering a variety of carbon literacy training and 'train the trainer' programmes to other city stakeholders.

By early 2017, over 6,000 stakeholders had completed carbon literacy training. However, the population of Manchester is around 500,000 people. The CLP thus faces a significant challenge in terms of how to scale-up activities to the level required to meet its stated aim of offering carbon literacy training to all the citizens of Manchester. As with the CLP and the city, Manchester Met likewise faces the challenge of how to offer carbon literacy training to all members of the university. It was therefore decided that the primary remit of the EEF would be to support student carbon literacy training delivered via a novel extracurricular cascade training model, where the model was designed to both increase students' employability skills, and extend the viability and scope of carbon literacy training at the university, and beyond (see **Figure 3**).

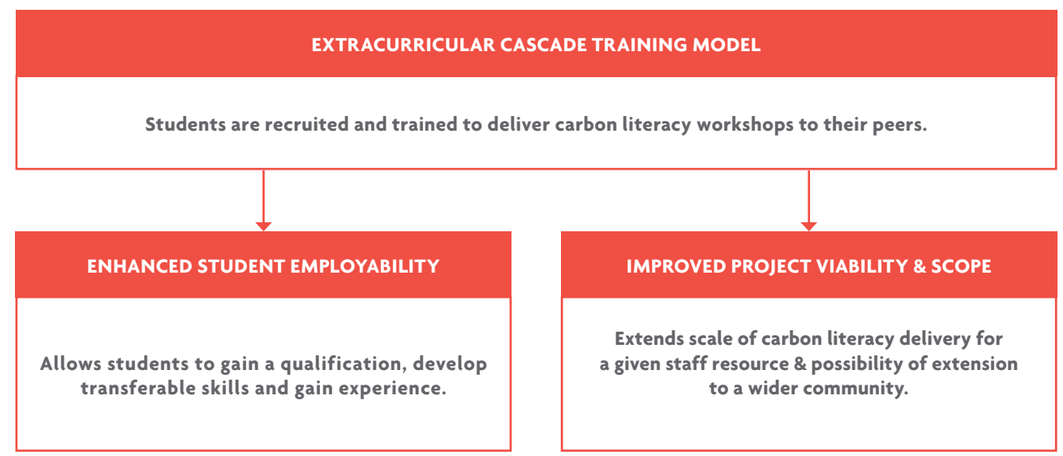
## DEVELOPING CARBON LITERACY FOR STUDENTS

In order to support the extracurricular delivery model, two training packages were developed by the academic and Environment Team staff together with a student intern: the Carbon Literacy for Students (CL4Ss) training course and the CL4Ss Train the Trainer programme.

In order to ensure that all students would have the opportunity to become CL4Ss trainers (irrespective of disciplinary background/depth of knowledge regarding climate change), and that the prospect of delivering the training was not too daunting, the CL4Ss training was developed as a two part programme. Part 1 focuses on the basic scientific knowledge of climate change and can be completed in one of three formats: (i) via an online e-learning module developed by the CLP, (ii) attendance at a climate change film screening and discussion panel, or (iii) attendance of a face-to-face session delivered by a member of academic staff (e.g. lectures and/or workshops embedded in the curriculum). Part 2 (the component delivered by student trainers) is a face-to-face workshop which focuses on taking action in response to climate change and explores how to communicate climate action to others. The workshop is highly interactive, comprising a series of activities that aim to stimulate discussion amongst the participants. Since the training was open to all students registered at Manchester Met it was anticipated that students from different disciplinary backgrounds would be able to bring different points of view to these discussions.

The development of the CL4Ss Train the Trainer programme was carried out in close consultation with the CLP, who reviewed the 'Carbon Literacy Trainer Standard' at the same time, in order to ensure that the student trainers would reach the standard required to formally qualify as a trainer.

The CL4Ss Train the Trainer programme is open to any student who has successfully completed the CL4Ss training, and was designed to enable carbon literate students to deliver the face-to-face element




▲ **Figure 3. The Manchester Met extracurricular cascade training model for delivering carbon literacy.**

of the CL4Ss training to fellow students. In order to qualify as a CL4Ss Trainer, the students have to attend five half-day training sessions. The programme focuses on developing training skills such as listening, questioning and presentation skills. The programme also offers students the opportunity to deliver the activities from the CL4Ss workshop to each other, as well as providing peer feedback. In the final session, the group co-deliver the full CL4Ss workshop together.

The student trainers have to commit to delivering at least four sessions: two sessions in which they are observed by a staff trainer, and a minimum of two further sessions per academic year, delivered independently with a peer (co-trainer). Students taking part in the scheme are paid for delivering the training (from the EEF via Manchester Met's student employment agency, Jobs4Students), and can also reflect on their experience and the skills they have developed in order to apply for the Future Skills Award, Manchester Met's extracurricular student employability award.

The programme has now been running for two academic years, where the training is reviewed on an annual basis in collaboration with the students that have completed the programme. To date, fourteen students have qualified as trainers and have collectively delivered the CL4Ss workshop to over 400 of their peers. Feedback from the student trainers indicates very positive outcomes, including an enhanced sense of responsibility to take action on climate change, enhanced team-working, leadership and communication skills, and perhaps most importantly, increased confidence.

## ENGAGING STUDENTS WITH THE WIDER COMMUNITY

Alongside working with students to provide carbon literacy training within the university, since 2013 Manchester Met staff have also been engaged to deliver carbon literacy training and train the trainer programmes to a wide range of external stakeholders, both within Manchester and further afield (**Figure 4**). The next evolutionary development of our project is to extend this wider engagement to the student body, where the first steps towards achieving this have already been taken. For example, two of our student trainers have successfully delivered CL4Ss to students at the Institut National Polytechnique de Toulouse, and undergraduate project students have evaluated training programmes within external organisations. In the coming year, students will be engaging with the Third Sector to develop and trial training packages aligned to their areas of special interest (such as nature and conservation based charities). In addition to actively involving students in these opportunities, as the body of carbon literate students and student trainers increases, we anticipate (and will encourage and support) more examples of student led initiatives to expand the delivery of carbon literacy training beyond the boundaries of Manchester Met. ES

| Training – 5 half-day workshops | |
|---|---|
| Introduction to the programme | • What is the CLP?<br>• What does it mean to be a CL Trainer?<br>• Activity practice & peer feedback |
| Essential trainer knowledge & skills | • Time management<br>• Active listening & questioning skills<br>• Inclusivity<br>• Activity practice & peer feedback |
| Dealing with worst case scenarios | • Dealing with difficult behaviours<br>• Activity practice & peer feedback |
| Presentation skills workshop | • Coaching delivered by colleague from School of Theatre |
| Assessment day | • The student trainers deliver the full CL4Ss workshop to each other<br>• Peer feedback |

| Assessed delivery – 2 CL4Ss workshops |
|---|
| • Assessed delivery of CL4Ss to 'real' participants<br>• Trainers deliver in pairs whilst being observed by programme leader and are provided with feedback at the end of the sessions<br>• If they pass both sessions, they are qualified CL4Ss Trainers |

| Ongoing delivery – 2 CL4Ss workshops |
|---|
| • Student trainers commit to delivering CL4Ss training on an ongoing basis (minimum 2 workshops per year)<br>• Students are provided with administrative support and are paid via the university student employment agency Jobs4Students |

▲ **Figure 4. Overview of the CL4Ss Train the Trainer programme.**

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**Jane Mörk** is a Senior Research Assistant in the School of Science and the Environment and Manchester Metropolitan University. Her main area of work is to develop and deliver Carbon Literacy training and the accompanying train-the-trainer programmes to university staff and students as well as to external organisations.

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# Students in their city

**Julian Holloway** and **Paul O'Hare** describe how encouraging students to reflect on the studentification of their own urban environments has real educational and social impact

Social dimensions of sustainability are frequently overlooked in academic and public discourse, despite being a key pillar of the concept alongside economic and environmental sustainability. Sustainability is often approached in ecological terms as referring to the access to and use of resources or the 'greening' of public policy interventions. Yet social sustainability – broadly construed – refers to other issues that are essential both to place liveability and to citizens' quality of life. These include – but are by no means limited to – social equity and social justice, social responsibility, social inclusion and exclusion, civic participation and engagement, and the need to manage diversity and difference. Such themes become all the more pertinent when we consider the challenges that emerge when disparate populations share the same urban spaces, raising fundamental concerns regarding the need to integrate all inhabitants in the creation of socially, environmental, and economically vibrant societies.

In this context, this article looks at the impact of significant numbers of students inhabiting urban neighbourhoods. As such, we heed the call made by Smith *et al.*[1] that in order to "Deeper understand studentification as a leading process of urban change that is reshaping communities and neighbourhoods", we need to engage with questions with regards to "Social sustainability, balanced communities, neighbourhood cohesion, social exclusion and segregation". In particular, this article outlines a pedagogic effort to encourage students to critically reflect on their engagement in the broader city in which they live, study, work and socialise, and ultimately with their wider student community.

## STUDENTIFICATION

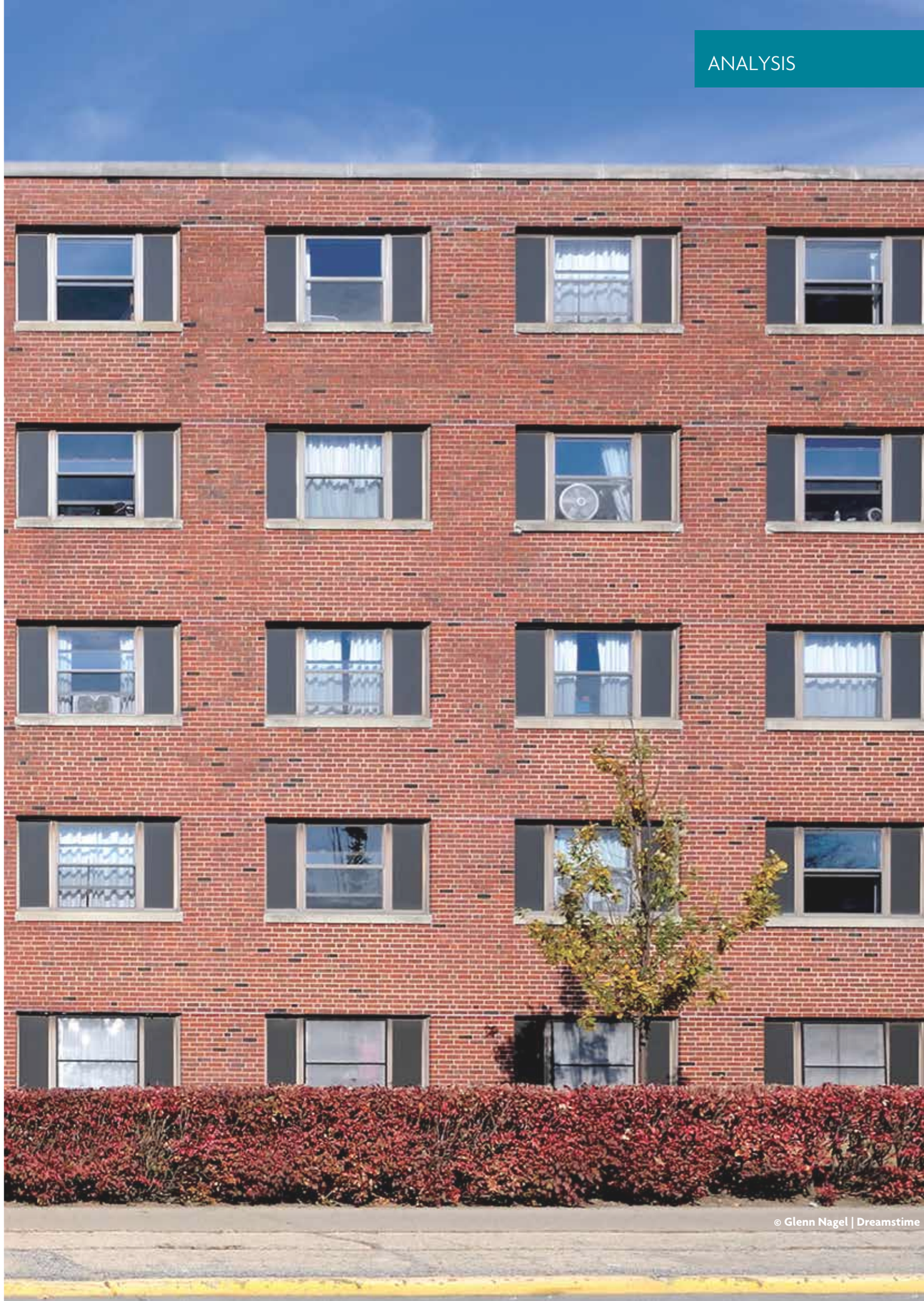
With 1.75 million people in Higher Education in the academic year of 2015-16 alone, students are a visible presence in many university towns and cities across the UK[2]. By consequence, many places are experiencing the economic, social, cultural, and environmental impact of student populations on both the areas surrounding universities and in the neighbourhoods where students live. The complex and dynamic processes by which the urban fabric is transformed by student populations and the attendant consequences of this change has been defined as 'studentification'.

The impacts of studentification are manifold and extensive, particularly when students concentrate in specific areas of cities in great numbers. Indeed, in some cases, students can become a defining characteristic of certain urban neighbourhoods, such as Headingly in Leeds[3], Sellyoak in Birmingham and Fallowfield in Manchester. One of the key impacts of studentification is on local property markets, with neighbourhoods becoming dominated by 'houses of multiple occupation' as local commercial landlords seek to cash in on the rise in student populations[4]. With such landlords able to charge by the room, families and local residents are often priced out of the market. The resulting demographic imbalance can have further consequences; areas of studentification have seen the closure of local schools and a shift in the retail and leisure landscape to one targeted at student tastes and lifestyles. Furthermore, studentification can have broader environmental impacts with increased levels of refuse, noise and anti-social behaviour. Student areas are also often subjected to higher levels of crime, particularly burglary.

In addition to the residential and environmental impacts of studentification, the consequences for the social and cultural fabric of neighbourhoods can be significant. Community cohesion is often inhibited due to students' residence being mainly during term time, often for just one or possibly two consecutive years. Consequently,



ANALYSIS



students often live lives that are at odds with the wider population, meaning that conflict with residents can emerge as a key issue. Research in Loughborough[5] revealed how residents have viewed increasing student numbers in particular areas as both a concern and a threat. Long-term residents of student areas are often displaced or left feeling marginalised or isolated. This raises questions for the social sustainability of areas where both students and long-term residents reside. If, as research has shown, students demonstrate low levels of pride in their environment, and are a source of conflict and concern for longer-term populations, can a sustainable sense of community, place and social cohesion be fostered or maintained?

## THE STUDENT LIVING LAB

As academics owing our livelihoods to the attraction of students to the city, and with keen professional interests in socio-spatial phenomena through our roles as researchers in the discipline of geography, we were acutely aware of how the presence of so many students has had a marked impact on the social, economic, and cultural fabric of the city. Greater Manchester has almost 100,000 undergraduate students across four universities[6], and as with similar cities across the UK, there is concern that relationships between students and 'host' communities are fraught. Periodic articles in the city's press often lament 'bad' student behaviour[7,8,] whilst the University of Manchester and Manchester Metropolitan University have recently temporarily funded private security patrols of public streets in a bid to address concerns regarding anti-social behaviour on the part of students.

In an effort to encourage students to reflect upon their impacts on their neighbourhoods and the city more broadly, whilst simultaneously developing and maturing key geographical techniques and analysis, we integrated the study of studentification into an introductory module entitling it "Introducing Human Geographies". This unit is designed to familiarise students with the breadth of concepts that comprise contemporary human geographies at Higher Education level. This included the development of students' abilities to understand and critique important academic sources in human geography, and to use and evaluate techniques and approaches to collect human geographical information.

After providing an introduction to political, social, economic, cultural and urban geographies, the final six weeks of the course specifically looked at the issue of studentification, a theme that would also provide the focus for the module's second assessment. The assessment culminated in a 1,000 word essay with a brief to "Describe and discuss the geographies of student identity".





In essence, the module encouraged students to read key literature around the theme of studentification, to design and execute semi-structured interviews and focus groups with their fellow cohort of geography and human geography students, and to develop an empirical qualitative dataset that students could analyse and reflect upon with reference to the published literature. Students were instructed to develop a thematic analysis of their data using the qualitative analytical technique of coding. Beyond the broad remit of geographies of student identity, students were permitted to collaborate to develop any themes that they felt were either important to their lives, or that resonated with them from the academic literature. Since the introduction of this unit, common themes that have emerged across the cohort include the following: the spatial implications of finance and part-time work; places of socialising and alcohol consumption; spaces of consumption and commercialisation; public safety and crime; student expectations and experiences; student community and cohesion; and the identification and discussion of places that students feel they are excluded from or are alienated within.

## PROMOTING REFLECTIONS ON SOCIAL SUSTAINABILITY

Studies submitted for the module assessment and retrospective discussions with students indicated that the assessment encouraged a significant degree of critical reflection on the part of the students. In particular, the act of consciously thinking about the student experiences of the city, discussing these in focus groups and interviews, and then evaluating these accounts in peer analysis and in the assessment write-up, permitted students to not only share their spatial interpretations of the city, but to hear and to learn from alternative accounts and experiences. Many students reported that this encouraged them to think more critically about their own impacts on the city – both positive and negative. Yet in a deeper sense, it became apparent that such efforts can challenge stereotypes and assumptions of what it means to be a student in the contemporary city, and ultimately to develop a more nuanced understanding of aspects of social sustainability. As is to be expected in an educational assessment, the extent to which this was executed varied across the cohort, but many students did develop a robust critique of studentification, reviewed its representation in academic literature and media, and explored how studentification is practised and performed by fellow students. This extended to critiques of the generation of their qualitative data (in terms of the partiality and composition of interviews and focus groups), and a contrast of their data with their own student experiences. Demonstrating this, several students wrote about how the work helped them appreciate the 'fluidity' of student identity, particularly how those they spoke to from different backgrounds experienced student-hood in varying ways and have contrasting experiences of city spaces and places.

We would argue therefore, that this sort of exercise has a number of key and critical benefits. Firstly, it allowed students and staff alike to explore a wider understanding and conceptualisation of what sustainability means. The emphasis upon social dimensions of sustainability encouraged students to become attuned to that particular strand of the concept. Secondly, it allowed students to demonstrate their understanding of both human geographical theories and those surrounding issues of sustainability in a context that is relevant to their (newly acquired) life. Finally, it allowed students, and indeed staff, to consciously explore the impact students had on the urban fabric in terms including, but not limited to, cohesive neighbourhoods, identity, exclusion, segregation, liveability and quality of life. This reflective learning in the Living Lab of the city and the classroom can, we hope, have a real impact on those experiencing – and who ultimately are responsible for – studentification in the contemporary city. ES

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**Paul O'Hare** is a Fellow of the Institute of Place Management and a Senior Lecturer in Geography and Development at Manchester Metropolitan University. His research focuses on resilience and participatory planning.

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