GOVERNING UNIVERSITY LIVING LABS FOR SUSTAINABLE DEVELOPMENT

Lessons from International Case Studies

Project report

Deep Dive #1: University Living Lab Governance

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Executive **Summary**

Universities have the capacity to discover, imagine, develop, and experiment with social and technical solutions to urgent global challenges such as climate change. **University Living Labs** represent an increasingly popular approach for universities to address these challenges defined as a *social and material infrastructure within a university for enabling a multitude of place-based, interdisciplinary, and impact-oriented research, education, operations, and enterprising projects of the university in collaboration with its societal partners.*

While university living labs facilitate real-world experimentation, they also generate organisational complexity. This challenge requires a better understanding of how university living labs are institutionalised and governed. This study aims to develop recommendations for effective governance of University Living Labs to address global challenges in general and which can be applied to the context of Monash University's transition to net zero emissions. The research asks:

1. How are university living labs organised and embedded in university policies and frameworks?

2. How do governance arrangements impact the continuity and coherence of university living lab activities?

This report presents key findings and recommendations based on a qualitative study of 18 university living labs around the world, drawing on interviews with academics and professional staff alongside existing literature.

The value proposition for university living labs centres on achieving research impact, enabling experiential learning for students, and integrating stakeholders and activities across institutional silos. University living labs contribute to the university impact agenda as a strategic priority and responsibility for universities to demonstrate the social relevance of research and education, often with a focus on sustainability and climate change. Living lab projects thus give university staff and students the opportunity to pursue their interests and apply theoretical knowledge in practice through real world experimentation and learning—both on campus and in partnership with practitioners and decision-makers. University living labs are transformative because they enable new modes of knowledge co-creation that bridge institutional divides between campus operations and academia, as well as between academic disciplines and external partners. This includes accelerating research translation and commercialisation of solutions in the community. Equally, university living labs offer financial benefits by mobilising external research funding, attracting students, and leveraging operational investment for research and teaching to deliver on university sustainability commitments.

A university living lab has four intersecting functions:

- A research process involving co-design and interdisciplinarity, experimentation and social learning in a real-world setting, and a focus on stimulating innovation and systems change.

- A teaching practice whereby students learn from and participate in applied research and industry engagement.

- Integrated campus management involving experimentation with, and innovative utilisation and management of, campus environments and specific built, natural, and digital assets.

- A partnership and engagement model for multistakeholder industry collaborations to address global challenges on and off campus.
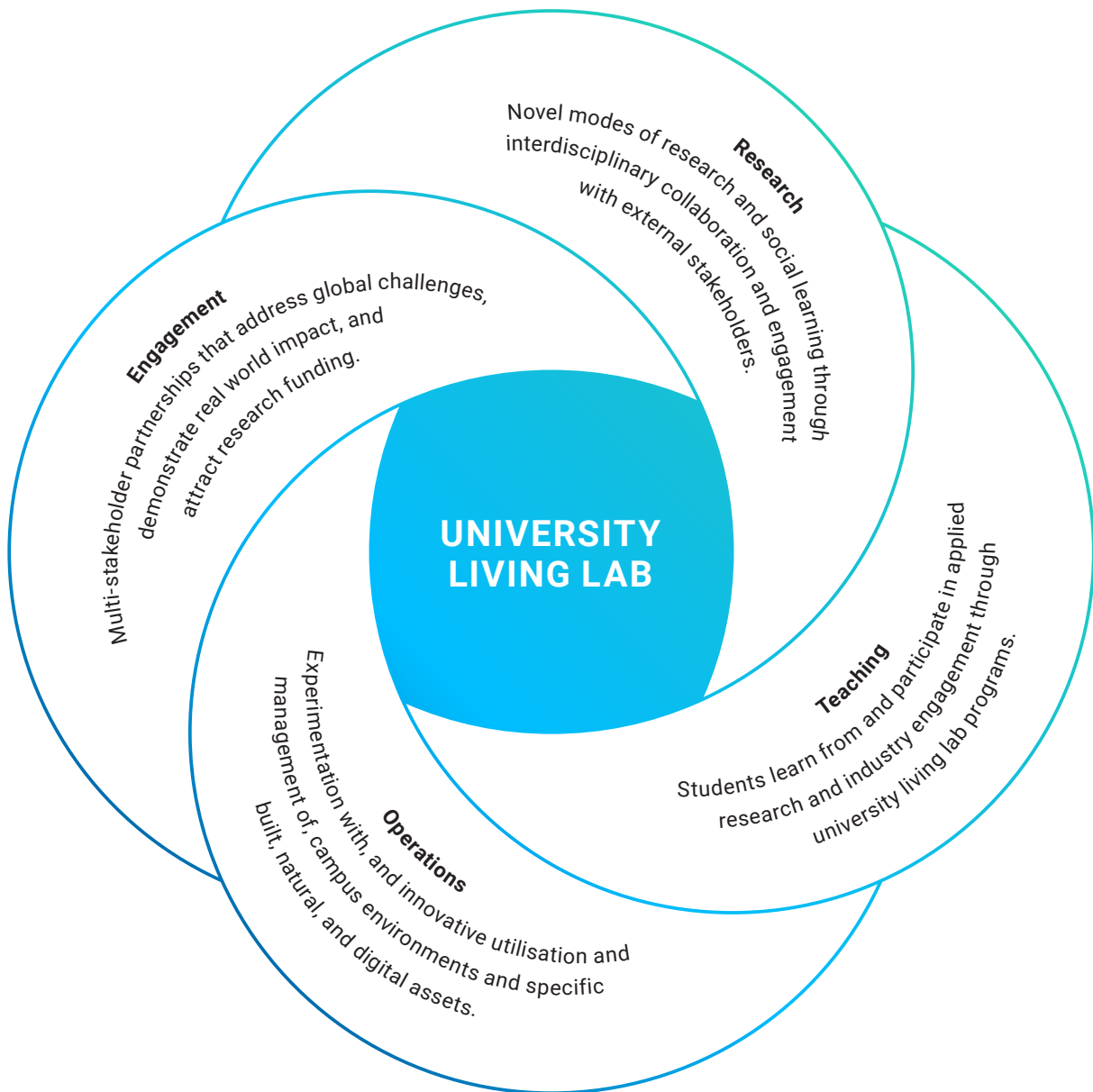
University living labs take a range of organisational forms to achieve these functions. The case studies in this report illustrate diverse **organisational approaches**, such as through a sustainability office, steering committees, research units, procurement, project management, student programs, and different modes of consultation and engagement. University living labs are guided by internal and external **policy frameworks**, including university sustainability and impact strategies, multilevel government strategies, funding schemes, and regulation, the UN Sustainable Development Goals (SDGs), and internal operating principles. **Funding mechanisms** include operational funding allocations, external and internal project-based funding, and revenue models. Finally, **knowledge translation** activities include innovation transfer (through commercialisation, policy change, implementation), education (through curriculum, professional development), research dissemination (through project databases, presentations, site tours), access to data, and public communications.

University living labs face a number of key challenges:

- **Existing governing structures affect continuity and scale of impact.** There is a lack of long-term strategy for funding and coordinating activities, including ensuring research and teaching is supported alongside infrastructure development. A lack of clarity around program ownership across different parts of the university can stall decision-making and affect buy-in. Central coordinating structures also tend to lack clear and uniformly implemented frameworks for partnerships, translation, commercialisation, and implementation of lessons and recommendations.

- **Ad hoc and project-based funding is insufficient.** Short-term and finite funding creates uncertainty, limits continuity, and focuses efforts on immediate needs at the expense of monitoring, evaluation, system change agendas, and dissemination of outcomes, as well as allocating sufficient funding for administration. Workload and time constraints affect participation and resourcing, while internal university funding structures can be misaligned with project timelines and time-consuming.

- **Siloed institutional cultures remain a barrier to collaboration.** Entrenched disciplinary and institutional boundaries include issues around institutional territory, lack of experience and knowledge of how to engage professional staff among researchers, and assumed hierarchies of knowledge. This kind of research is also higher risk for academics due to poor alignment with traditional academic metrics in terms of resourcing, outputs, and timeframes. As a result, collaboration often depends on individual relationships, leaving initiatives vulnerable to staff changes and limiting accessibility.

- **Wider participation is limited by a lack of shared understanding.** The "living lab" concept remains abstract and is interpreted in different ways, while raising issues for some due to its perceived technical connotations. A key challenge is thus to balance specificity and inclusion in defining an institutional narrative. Limited dissemination of knowledge, outcomes, opportunities, and available resources exacerbates this challenge.
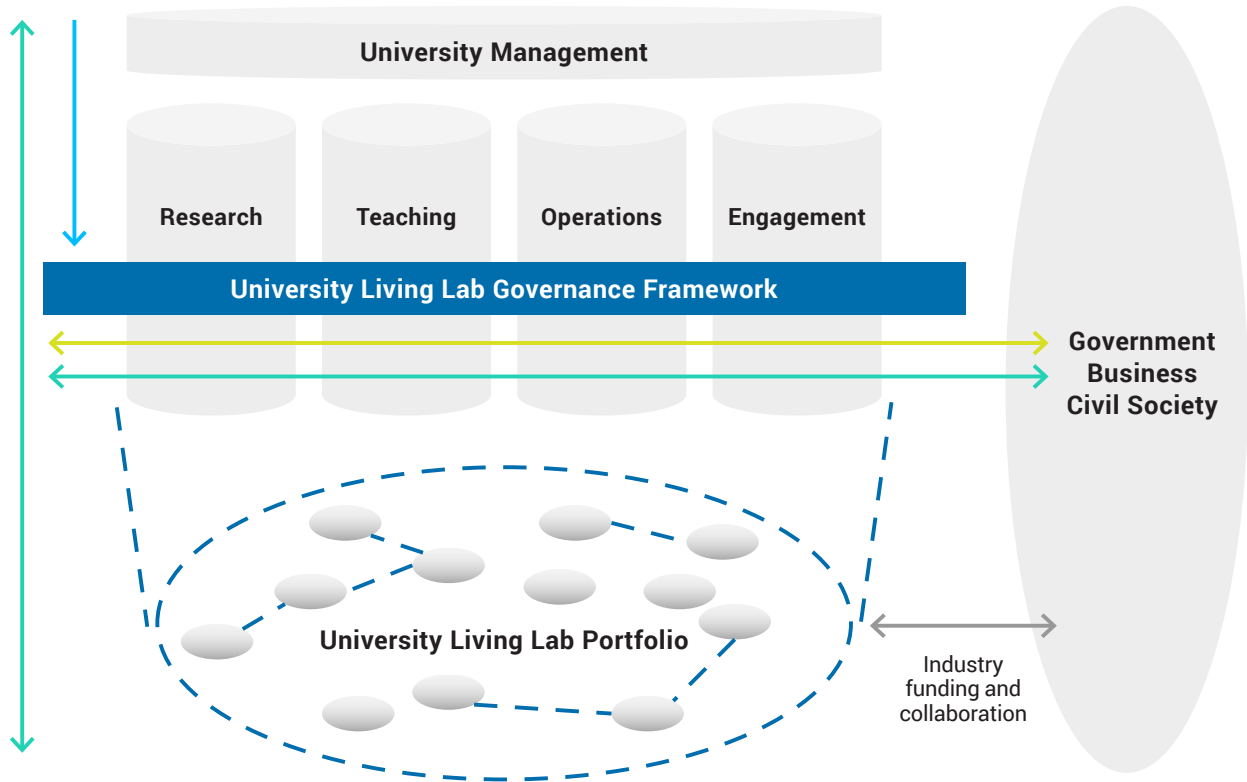
The institutional embedding of a living lab approach in a university typically evolves through discrete initiatives and the efforts of individual champions to demonstrate and communicate value, and alignment with the aims of university management in terms of sustainability and climate change. A university living lab governance framework is needed to generate a culture of collaboration across research, teaching, operations, and enterprise and accelerate impact, without stifling emergence and innovation. **We identify four enabling mechanisms for effective university living lab governance:**

- **Relationship-building and facilitation** across institutional silos and disciplines, and cultivating trust through interpersonal connections.

- **Flexible coordination** of university living lab activities through the establishment of a representative and participatory decision-making authority and forum with a shared and inclusive vision and objectives to direct and mobilise activity.

- **Communicating and demonstrating value** through inclusive language to build a public profile, disseminate knowledge, and cultivate buy-in among senior leadership to scale up impact.

- **Investment in people, systems, and capabilities** for program management and other supporting systems and expertise (such as partnerships development, commercialisation, data management, and communications) to provide certainty and facilitate continuity and expansion of activities.

Right: Nanyang Technological University, Singapore

Enablers Of Effective University Living Lab Governance

University Management

Research   Teaching   Operations   Engagement

University Living Lab Governance Framework

Government
Business
Civil Society

University Living Lab Portfolio

Industry
funding and
collaboration

Flexible coordination	**Investment**	**Facilitation**	**Communication**
▪ Decision-making authority	▪ Budget allocation for governance framework	▪ Relationship building and external partnerships	▪ Disseminate knowledge
▪ Stakeholder representation and participation	▪ Investment in personnel and key systems	▪ Interpersonal trust	▪ Inclusive language
▪ Vision and objectives			▪ Clear value proposition
▪ Make resources accessible			▪ Cultivate executive buy-in

Our research reveals a diversity of approaches to the governance of university living labs that speaks to the heterogeneity, complexity and uncertainty of these endeavours. Coalitions of actors should come together and develop governance approaches that are in dialogue with the visions and values of their universities and social contexts. **We recommend the following practical steps towards realising an effective governance approach for university living labs:**

- Establish a steering group with broad representation of academic and professional staff and students and a decision-making mandate to develop strategic goals and an annual plan, engage with university stakeholders, leverage existing programs, disseminate achievements and opportunities, and advance living lab investment and activities;

- Identify and develop transparent and accessible toolkits, resources and processes to distribute university-wide support and connect a broad ecosystem of living lab activities across disciplines, faculties and settings.

- Provide ongoing resourcing to support a core team of university living lab program leads to communicate the vision and value proposition to different audiences and coordinate capability building in terms of skill development, facilitation support, and interdisciplinary research methods;

- Develop broad stakeholder engagement to co-design or re-imagine the internal value proposition across the university's key pillars (e.g. research, education, operations and enterprise);

- Engage with industry and government partners and other funding bodies to co-design the external value proposition and iterate over time as circumstances change;

- Develop and communicate a broad and emergent definition of a University Living Lab based on key principles of: transdisciplinarity, university-industry collaboration, experimentation, learning-by-doing, innovation, and impact to enable inclusive and broad participation; and

- Establish systems and metrics for impact assessment, monitoring and evaluation and dissemination of results, case studies and feedback.

TABLE OF CONTENTS

Background

From its founding in 1958, Monash University has risen from a single campus into an education and research leader committed to developing solutions that address the grand challenges of the 21st century. Monash is ranked in the world's top 50 (THE), is a member of the prestigious Group of Eight and Australia's largest University. In 2016 Monash committed to the UN Sustainable Development Goals and in 2017, launched the Net Zero Initiative with an ambitious target to achieve net zero emissions by 2030 for its four Australian campuses.

In 2021 Monash released its Impact 2030 strategy articulating the university's core vision to address major challenges of our age: climate change, geopolitical security, and thriving communities. In the same year, Monash announced an Alliance with global energy company ENGIE to co-develop, test and deploy net-zero solutions at scale. Through Impact 2030 and the Net Zero Initiative, Monash University continues to be a leader in higher education and research by driving transformative change in response to the global challenges of our age. An ecosystem of Monash Living Labs promises to accelerate the realisation of these ambitions through research, education, operations, and enterprise across the university and through collaborative engagement with local and international partners

To achieve its 2030 net zero emissions target, Monash entered into a long-term strategic partnership with ENGIE in 2021. A key strategic objective of the Monash-ENGIE Alliance is to develop a coherent governance approach for university living labs to progress a transformative sustainability agenda. Several living lab projects have already been undertaken, are underway or being planned at Monash campuses. These projects include the HumaniSE (Human-Centric Software Engineering) Lab in the Faculty of Information Technology involving the development of inclusive software solutions for social good that can overcome the digital divide. The National Centre for Health Ageing (NCHA) Living Lab program develops and tests new health care models in collaboration with industry and end users, and the Turner Living Lab launching in 2023 will track health outcomes post COVID-19 in collaboration with community and government health services. The Melbourne Experiment explores the effects of COVID-19 on the city through interdisciplinary research collaborations. The Zero Emission Bus Living Lab, led by the Department of Design will investigate Electric Bus technology being trialled at the Clayton Campus and the logistics of operating battery powered vehicles along busy bus routes. The Net Zero Precincts ARC Linkage project will run living lab experiments in energy, mobility and the built environment to develop and test new governance approaches to net zero transitions within the Monash Technology Precinct.

These examples of living lab experiments demonstrate the exciting potential of interdisciplinary research and education, yet there is limited coordination between living lab projects and practitioners, and the development of a coherent strategy and supporting function is now recognised as a key aspect to realise deeper engagement and impact for the University.

1. Introduction

1.1 Transforming Monash University towards net zero emissions

Universities have the capacity to discover, imagine, develop and experiment with social and technical solutions to urgent global challenges such as climate change. The value of interdisciplinary and collaborative applied research and education for driving sustainable innovation on campus and in the community is well-recognised in research and practice.

University Living Labs[1] are a popular for universities to address global challenges which we define here as a *social and material infrastructure within a university for enabling a multitude of place-based, interdisciplinary, and impact-oriented research, education, operations, and enterprising projects of the university in collaboration with its societal partners.*

The transformative potential of University Living Labs is influenced by a shared sense of directionality, effective social learning, and institutional embedding.[2] Universities like Monash are establishing ambitious societal impact agendas, including climate change mitigation and adaptation targets. In this context, University Living Labs offer the means through which diverse stakeholders—spanning institutional silos, disciplines, and external partnerships—can explore and test socio-technical solutions. Through these processes, University Living Labs create spaces for social learning among participants, their wider networks, and the institutions in which they are situated by generating new knowledge and problematising accepted norms, values, policies, and practices.

To avoid short-term interventions and drive systems change in complex environments, University Living Labs benefit from a degree of embedding within specific institutional contexts.[3] University governance frameworks can be strengthened to foster collaboration and social learning and support a portfolio of living lab activities that address global challenges.[4] Visible and tangible social infrastructure is necessary to establish inclusive pathways for participation and agency without reinventing the wheel, such as through engagement opportunities, networks, and relationship building.[5] Distributed skills, capabilities, and peer support are critical to strengthen living lab design, implementation, and knowledge transfer across diverse disciplines and settings.

1.2 Learning from University Living Labs

This study aims to develop recommendations for effective governance of University Living Labs to address global challenges in general and which can be applied to the context of Monash University's transition to net zero emissions.

Governance is broadly understood in terms of stakeholder roles and relationships, policies and processes, and resource mobilisation. The research asks:

1. How are university living labs organised and embedded in university policies and frameworks?

2. How do governance arrangements impact the continuity and coherence of university living lab activities?

To answer these questions, the research presented in this report draws on existing literature and interviews with academics and professional staff involved in select university living labs globally, including Monash University. Interviews explored:

- Visions and objectives

- Organisational structures, roles and responsibilities

- How decisions are made

- How university living labs are resourced

- Achievements and lessons learned

The 18 university living lab case studies comprising this study exemplify the diverse possibilities and potentials of a university living lab approach to addressing global challenges such as climate change. Cases were selected based on a preliminary desktop search for university/campus living lab initiatives with a public profile and some detail on their approach, as well as via professional networks of the research team.

This report does not document emission reductions and other outcomes of university living labs relevant to global challenges around the world. Instead, the report focuses on the kinds of objectives and actions pursued through living labs, and the processes and structures underpinning and enabling living lab activities and outcomes. Importantly, the report explores university living lab governance challenges and enablers to illuminate key barriers and pathways for growing the impact of universities in addressing global challenges such as climate change.

CASE STUDIES

The case studies at the centre of this report are located across nine different countries as shown in the map below. For more information, see Appendix 1 for details of each case study and Appendix 2 for an anonymised list of research participants.

- Deakin University – Living labs *(Geelong, Australia)*
- Monash University – Net Zero Initiative / Net Zero Precincts *(Melbourne, Australia)*
- RMIT University – IC 3 P *(Melbourne, Australia)*
- University of Melbourne – Campuses as Living Laboratories *(Melbourne, Australia)*
- University of Tasmania – Sustainability Integration Program for Students (SIPS) *(Hobart, Australia)*
- Western Sydney University – Living Labs *(Sydney, Australia)*
- State University of Campinas – Campus Sustentável (Sustainable Campus) *(Campinas, Brazil)*
- Concordia University, Canada – Living labs *(Montreal, Canada)*
- University of British Columbia – Campus as a Living Lab *(Vancouver, Canada)*
- University of Toronto – Campus as a Living Lab *(Toronto, Canada)*
- La Rochelle University – Smart Campus *(La Rochelle, France)*
- University of Stuttgart – CampUS hoch i (Real-World Laboratory) *(Stuttgart, Germany)*
- Delft University of Technology (TU Delft) – The Green Village / Living labs *(Delft, The Netherlands)*
- Utrecht University – Living Labs for Sustainable Development (UULabs) *(Utrecht, The Netherlands)*
- Nanyang Technological University (NTU) – Energy Research Institute @ NTU (ERI@N) *(Singapore)*
- University of Edinburgh – Living Lab projects *(Edinburgh, UK)*
- University of Manchester – University Living Lab *(Manchester, UK)*
- Ohio State University – Ohio State Energy Partners (OSEP) *(Columbus, US)*

2. Why University Living Labs?

A living lab approach to university research, teaching, partnerships, and campus management focuses on real world problem-solving through collaborative action between academics, professional staff, students, government, industry, and the wider community.[7]

Participants involved in this study highlighted the value of a university living lab in terms of **achieving research impact**. Impact is broadly recognised as a strategic priority and responsibility for universities to demonstrate the social relevance of research and education. Living labs provide spaces for researchers to meaningfully engage and partner with diverse stakeholders from the outset, develop shared understanding of problems, and learn from real world development and accelerated testing of solutions to global challenges—rather than conducting research in isolation. The university living labs in our study each respond to sustainability and climate challenges in various ways, including explicit reference to the United Nations Sustainable Development Goals (SDGs). This impact agenda is a significant part of university communications, identity, and demonstration of leadership. Part of this value proposition is the opportunity to leverage research funding through grants and industry partnerships, and operational investment in university facilities.

"[…] it used to be enough for universities to do research and teaching. Those are the two missions. But there's increasing calls for the so-called third mission of engaging with society. And we need to engage. Society is demanding more from us. So, we need to create this community of scholars that is going to respond to those demands."

— **University of Toronto, Leadership (research), June 2022**

"[…] we have 500 buildings, 10 campuses, we're like a distributed LGA [local government area], and all of the professionals dealing with our area deal with the realities, whether they're transitions to renewable energy—all the things that people look at out around our community, they also occur within our campuses."

— **Western Sydney University, Manager (operations), July 2022**

"[…] we have a lot of opportunity to help others achieve their sustainability goals through actions that we can demonstrate and learnings that we can help develop and then disseminate throughout our stakeholder communities outside of the university."

— **Ohio State University, Leadership (research), August 2022**

A related value is that university living labs **enable experiential learning for students**. Students are often motivated by environmental and social challenges in their studies and look for real world experiences alongside traditional coursework. Living lab projects give students the opportunity to pursue their interests and apply theoretical knowledge in practice through real world experimentation and learning—both on campus and in partnership with practitioners and decision-makers. In doing so, students gain experience and develop relevant skills and important insights for future employment and civic participation. In this way, university living labs help to attract students as part of the university brand.

"[...] I think for some students they are already very passionate about sustainability and this is what they want to do in their career. So we're helping them to see how they can bring the ideas that they have into practice and that they can actually see and touch or they can physically experience the idea that they had before they came into the program. But we're also here for students who may be interested in sustainability, but don't know how to get involved, so we're providing them with the pathways to do that as well."

— **University of Tasmania, Senior Officer (operations), July 2022**

"[...] employability for students; the number of students we have who've got jobs based on the living lab project they did. Some of them have got jobs with the organisation they did the report for, but far more common is they can talk about it in job interviews, and it's absolute gold dust."

— **University of Manchester, Leadership (research), July 2022**

A third key value and feature of a university living lab approach is the **integration of stakeholders and activities across institutional silos**. University living labs are transformative because they bridge institutional divides between campus operations and academia, as well as between academic disciplines and external partners. University living lab activities are underpinned by relationships between diverse stakeholders and provide space for collaboration through on- and off-campus projects, thematic committees, and university-wide initiatives. This integration has commercial value for the university in terms of leveraging capital expenditure in research and teaching to deliver on university sustainability commitments.

"[...] education, research, operations, it's all of that working in a symbiotic environment that gives value to each of those components and recognises the importance of each of those components in the process. So it's a genuine co-development as opposed to an afterthought in the planning process"

— **Monash University, Leadership 2 (research), July 2022**

"[...] The university's primary business is education from a commercial perspective and then research as well. The living lab approach allows us to use our multibillion-dollar campus infrastructure, not only for spaces for teaching and research but allows them to use that investment to support teaching and research as well [...] You're getting a double bang for your buck on what that investment is."

— **Monash University, Leadership (operations), June 2022**

3. What are the functions and organising structures of University Living Labs?

In practice, these abstract visions and objectives translate into **four actionable systems** and processes that transect the four pillars of the university: research, education, operations, and engagement.[4] Based on a comparative analysis of the case studies in our study, the forms and examples articulated below represent distinct though often overlapping approaches to university living labs.

Research — Novel modes of research and social learning through interdisciplinary collaboration and engagement with external stakeholders.

Engagement — Multi-stakeholder partnerships that address global challenges, demonstrate real world impact, and attract research funding.

Teaching — Students learn from and participate in applied research and industry engagement through university living lab programs.

Operations — Experimentation with, and innovative utilisation and management of, campus environments and specific built, natural, and digital assets.

UNIVERSITY LIVING LAB

Our research demonstrates that there are no uniform, best practice governance models for organising university living labs—there are a diverse range of drivers, objectives, and institutional environments that each case study responds to in different ways. Table 1 below summarises the breadth of **organising structures** exhibited by the cases and which underpin the four key functions of university living labs (see Appendix 1 for more detail on each of the case studies).

In what follows, the research, teaching, operations, and engagement functions of university living labs are explored, illustrated by select case studies.

TABLE 1: Summary of organising structures of University Living Labs

Category	Examples	Description (with illustrative cases)
Organisational approach	*Sustainability office*	Operational unit of the university responsible for sustainability initiatives, including university-wide sustainability plans, where university living lab initiatives are managed (e.g. **Deakin University, State University of Campinas, University of Edinburgh, University of Tasmania, Western Sydney University**)
	Steering committee	Provides governance and oversight, representative of key university stakeholders (often senior leadership), guided by Terms of Reference, and sometimes embedded in the university executive (e.g. **University of British Columbia, University of Toronto**)
	Thematic committees	Domain-based expert groups focused on living lab projects on energy, waste, education etc. (e.g. **State University of Campina**s Sustainable University Management Group technical chambers)
	Strategic planning	University living lab approach embedded in a strategic plan (e.g. the **University of Melbourne**'s Sustainability Plan 2030) with nominated portfolios for implementation, performance metrics, and targets.
	Research unit	Responsible for project implementation, including collaboration (e.g. Energy Research Institute at **Nanyang Technological University**; ZIRIUS Centre for Interdisciplinary Risk and Innovation Studies at the University of Stuttgart)
	Project manager	Responsible for project implementation (e.g. **La Rochelle University**)
	Procurement	Industry partner contracted to provide campus management infrastructure and services (e.g. Ohio State Energy Partners at **Ohio State University**)
	Consultation and engagement	Includes: ▪ Ideation and co-design through surveys, workshops, competitions (e.g. **University of Stuttgart, Utrecht University**) ▪ Industry partnerships at the university level (e.g. **Monash University**'s Woodside Monash Energy Partnership and Monash-ENGIE Alliance) and project level (e.g. **Nanyang Technological University, University of Stuttgart, Utrecht University**) ▪ Development of communities of practice (e.g. **University of Melbourne**)
	Student programs	Includes: ▪ Sustainability courses where living lab projects are part of the assessment (e.g. U**niversity of Manchester, University of Toronto**) ▪ Internship programs (e.g. **University of Edinburgh, the University of Melbourne, University of Tasmania**)

Category	Examples	Description (with illustrative cases)
Policy framework	*University sustainability plan*	Sets broad university-wide targets and objectives for sustainable campus operations and sustainability research and education (e.g. **La Rochelle University, Monash University, Ohio State University, RMIT University, University of Tasmania**) with reference to a living lab approach for implementation (e.g. **Deakin University, Nanyang Technological University, State University of Campinas, TU Delft, University of British Columbia, the University of Melbourne, Utrecht University, Western Sydney University**)
	University impact strategy	Sets objectives for the university's social impact (e.g. **Monash University**)
	Government policy	Includes: ■ Municipal decarbonisation strategies (e.g. reference to the university as a demonstration site in the case of **La Rochelle University France**) ■ State government climate legislation (e.g. directive and funding scheme for universities to be carbon neutral by 2030 in the case of **University of Stuttgart** Germany) ■ Government legislation (e.g. requiring energy corporations to invest in R&D in the case of **State University of Campinas** Brazil) ■ National government research policy, establishing research priorities and funding mechanism (e.g. in the case of **Nanyang Technological University** Singapore) ■ Regulatory exemption for experimentation in the built environment across levels of government (e.g. in the case of The Green Office at **TU Delft** in the Netherlands) ■ National level university public procurement regulation governing industry partnerships (e.g. **La Rochelle University** in France)
	UN Sustainable Development Goals (SDGs)	Reference to the SDGs at a project level in terms of project scope (e.g. **State University of Campinas, University of British Columbia, University of Edinburgh, University of Manchester, University of Toronto, Utrecht University**)
	Living Lab principles	Operating principles guiding project selection (e.g. The Green Office at **TU Delft, Utrecht University**)

Category	Examples	Description (with illustrative cases)
Funding mechanisms	*Operational funding*	Includes: ▪ University capital budget allocation for infrastructure (re)development (e.g. **Monash University, TU Delft**) ▪ University funding allocation for organisation and salaries (e.g. **University of Stuttgart** Green Office, **University of Tasmania** Sustainability Office, **Utrecht University**) ▪ Operational sustainability investment in small facilities to support research (e.g. W**estern Sydney University**)
	Project-based funding (external)	Includes: ▪ Government research funding (e.g. **Monash University, Ohio State University, RMIT University, University of Stuttgar**t) ▪ Industry funding (e.g. **Monash University, State University of Campinas**)
	Project-based funding (internal)	Includes: ▪ Provision of competitive seed funding and awards (e.g. **University of British Columbia, University of Toronto**) ▪ Private sector endowment (e.g. **Ohio State University**) ▪ Paid student internships (e.g. **University of Tasmania**) ▪ Student scholarships (e.g. **State University of Campinas, Utrecht University**)
	Revenue models	Fee for service (e.g. the Green Village at **TU Delft**)
	Rent	Rent paid for living lab facilities / land (e.g. to government in the case of **Nanyang Technological University**)

Category	Examples	Description (with illustrative cases)
Knowledge translation	*Innovation transfer*	Includes: ▪ Commercialisation of innovations (e.g. **Monash University, Nanyang Technological University**) ▪ Implementation of recommendations in campus operations (e.g. **University of Edinburgh, University of Tasmania**) ▪ Policy recommendations (e.g. **Monash University**) and development of system management methodologies for government (e.g. **State University of Campina**s)
	Education	Includes: ▪ Curriculum development (e.g. **La Rochelle University, Ohio State University**) ▪ Community capacity building (e.g. **Monash University**) ▪ Professional development (e.g. **Monash University, State University of Campinas**)
	Research dissemin-ation	Includes: ▪ Project database (e.g. **University of British Columbia, University of Edinburgh, University of Manchester, University of Toronto, Utrecht University**) ▪ Conference presentations, webinars, pavilions (e.g. **Deakin University, Monash University, University of Stuttgar**t) ▪ Public tours (e.g. **Monash University, Nanyang Technological University**) ▪ Published book (e.g. **State University of Campinas**)
	Access to data	Preparation and sharing of operational data internally and through partnerships (e.g. **Monash University, Ohio State University, State University of Campinas, the University of Melbourne**)
	Communi-cations	Includes: ▪ Website (e.g. **State University of Campinas, University of Manchester, University of Tasmania**) ▪ Social media (e.g. **State University of Campinas**) ▪ Campus climate barometer (e.g. **University of Stuttgart**)

3.1 A research process

The living lab concept captures novel modes of research and social learning at universities, characterised by challenging traditional disciplinary boundaries and unidirectional engagement with external stakeholders.

University living labs are defined in different ways by those involved in living lab activities. Nevertheless, interviews with academics and professional university staff highlight three key attributes.

Research is co-designed and transdisciplinary.
University living labs bring together different forms of knowledge, including experiential knowledge of "end users" and practitioners, to define research problems and methods, and develop research findings and solutions. This "big tent approach" (University of British Columbia, Leadership (operations), July 2022) to research moves beyond knowledge dissemination and translation by involving stakeholders in knowledge production from the outset.

"[...] the basic idea is it's not up to the academics to define the research questions, to define the research methods, to do the research, and to interpret the result. That has to all be co-managed and co-undertaken."

— **University of Toronto, Leadership (research), June 2022**

"[...] What's the point of a university if we don't have students and professional staff and academic staff working together? We need to be able to learn from each other."

— **University of Tasmania, Senior Officer (operations), July 2022**

Research involves experimentation and social learning in a real-world setting. For university living labs, the real-world setting is sometimes the campus itself where social, technical, and ecological facilities and environments are being developed, maintained, used, and increasingly reconfigured in response to global challenges such as climate change. This context represents an opportunity to explore research questions and learn-by-doing through experimentation which requires openness to uncertainty, learning from failure, and challenging underlying assumptions.

"[…] the university itself is going through transformation and a major transition towards net zero and we don't know how to do it. No one has done it before so it needs to be a learning by doing approach, a testing and trialling approach, an interactive approach and that's where that living lab piece I think can come in."

— **Monash University, Leadership 3 (research), July 2022**

"[…] students have been solving sustainability problems in other courses in principle. But I wanted to put them in touch with actual decision makers with real jurisdictional issues and real boundary constraints and real politics and so on. So, to understand a little bit about how you actually make change in the world as opposed to in principle in a paper."

— **University of Toronto, Leadership (research), June 2022**

"[…] we're actually using the universities simply as a workplace, so we're de-exceptionalising universities in that sense, really trying to understand them as a virtual and multi-sited space in which people across all sorts of professions and occupations come together to basically run a really large and complex organisation. So because universities are like that – a little bit of a microcosm of the world […] we're really drawing out general lessons about climate change impacts and adaptation from the university context. […] we're simply trying to turn the university inside-out to see it as a space that is already necessarily experimenting because we live in a climate change context"

— **RMIT University, Leadership (research), July 2022**

University living lab experiments aim to stimulate innovation and systems change. Experimentation and knowledge co-production establish pathways for developing social and technical innovations in response to real-world problems. Universities operate in complex and uncertain environments and seek to develop translation pathways for basic research to drive engagement, impact and system transformation. Living Labs provide the opportunity for research participants to collaboratively develop solutions that seek to influence the speed and scale of innovation across a variety of socio-technical systems.

"[…] we call it the hopscotch jump approach, so you have the fundamental research [which] we are doing at the university campus, at the faculties. And you take the first hop to a very experimental site where you can test your early prototypes, in a system environment, in a realised environment, more or less. And then if you have corrected the first faults in your product, you go to a bigger site, a living lab, which is actually our campus. […] And then you scale up to real neighbourhoods"

— **The Green Village, Manager (research), June 2022**

Campus as a
Living Lab

at University of British Columbia (UBC), Canada

Above: University of British Columbia, Canada

What is the purpose of the university living lab? Since 2002 (and formally since 2010), the University of British Columbia (UBC) has employed a Campus as a Living Lab (CLL) approach to applied research and demonstration of sustainable innovation on campus in response to global challenges.

How is the university living lab organised?
The program management team comprises members of the Urban Innovation Research team in UBC's Sustainability Hub, including the Director of Urban Innovation Research, a research manager, and program assistant. Governance and oversight is provided by the CLL Steering Committee within the University's sustainability governance framework under the Executive Steering Committee and is co-chaired by senior representatives of research and operations. The committee comprises 14 senior members across academic and administration (including the Vice President

Research and Innovation Office, Sustainability Hub, and the Associate Dean Research, Faculty of Applied Science), and operational stakeholders (including Campus and Community Planning, Energy Conservation and Innovation, Engineering and Utilities, Infrastructure Development, Student Housing and Community Services, and Sustainability and Engineering).

The University's Strategic Plan (2018) refers to the CLL model in how the university seeks to achieve its sustainability objectives on campus, as well as to support sustainable development in the community. The initiative is guided by key values of 1) sustainability, 2) equity and inclusion, 3) transparency, and 4) collaborative learning and reference to the Sustainable Development Goals (SDGs) at the project level, while the CLL Steering Committee is governed by Terms of Reference.

What are the main activities of the university living lab? A key element of UBC's living lab activities is an annual internal competitive seed fund (CLL Funding Competition) for projects that involve partnerships between faculty researchers and operational staff. CAD$200,000 is awarded each year across about 4 small projects that leverage other sources of funding and are intended to develop into larger initiatives over time. One of the benefits of the competition is that it is considered "*more accessible*" than federal funding with much lower success rates. The Steering Committee selects seed projects as well as overseeing larger projects and undertaking strategic planning through monthly meetings.

The CLL website details funded projects, while the UBC Sustainability Research Collections site provides case studies of interdisciplinary and applied sustainability research and innovation.

Above: University of British Columbia, Canada

Net Zero Precincts
ARC Linkage
at Monash University, Australia

What is the purpose of the university living lab?
The Net Zero Precincts ARC Linkage project uses Monash University's main campus in Clayton and the Monash Technology Precinct as sites to collaboratively experiment, test and learn about net zero solutions at precinct scale. The project aims to develop a transferable step-by-step transition framework that will support the design and roll out of net zero precincts by industry and government in Australia and elsewhere.

How is the university living lab organised?
The project is funded by an Australian Research Council (ARC) Linkage grant for four years (2021-2025) and contributes to Monash's AUD$135m Net Zero Initiative and net zero emission target by 2030 for its Australian Campuses. The Monash-ENGIE Alliance is a multi-year industry partnership that underpins the Net Zero Precincts project with additional project partners including the City of Monash, ICLEI - Local Governments for Sustainability

(Oceania) and CSIRO. The project is led by researchers from Monash Sustainable Development Institute and the Emerging Technologies Research Lab. 5 PhD students will work on a range of net zero living lab experiments that will engage with partners and members of the precinct community. The project's interdisciplinary approach integrates social science research with the design, testing and exploration of engineering, design, data science and IT solutions.

What are the main activities of the university living lab?
Drawing on transition management and design anthropology perspectives, the Net Zero Precincts project responds to the lived experiences of the precinct community and its businesses, government, knowledge and civil society actors. This project is developing an interdisciplinary and applied approach to the transition of urban infrastructures at precinct scale.

Stage 1 saw the project team undertake over 50 qualitative interviews to understand the drivers and barriers that frame the precinct community's experiences, expectations and visions of net zero precincts. Stage 2 will co-create and envision collective and shared pathways to net zero precinct futures which are aligned with the precinct community's everyday social, political and experiential realities and expectations. Stage 3 will see PhD students work on living lab experiments in energy systems, net zero mobility, the built environment, local governance and data science. Living Lab experiments can take various forms, including material interventions (e.g. on-site demonstrations), social, policy, technological or economic interventions (e.g. introducing design probes and prototypes) or virtual interventions (e.g. through design visions or digital interactive design).

Above: Monash University, Australia

3.2 A teaching practice

Students can learn from and participate in applied research and industry engagement through university living lab programs. Students can be involved in research teams, conduct independent projects as part of their coursework and assessment, and undertake work placements at the university.

These activities involve collaboration with academics, operations staff, and industry partners on and off campus. Student projects often focus on improving campus sustainability and the evidence and recommendations generated can inform university policy and implementation. Others might report to industry partners in response to their needs and questions.

"[...] we have thousands of students and they are very creative and they are very capable, so if we could bring these students to contribute to the problems that we have inside the university it would be good to everyone, to the university, also for their education. Because they have, let's say, a very theoretical education: just classes and exams, classes and exams."

— **State University of Campinas, Manager 1 (research), June 2022**

"[...] I taught a course this past January called an Urban Living Lab course. And it was 56 first year master students in the Munk School. I put them all to work on projects related to the city of Toronto's climate strategy. It's called TransformTO. So, I went to my friends in the city and I said, "We're going to have 56 students. Can we come up with 12 projects that you want done?" So, went through a whole process, they produced a 24-page document laying out these 12 projects and what their interests were. And then the students came to the first class, they voted on which one they were interested in, we assigned them"

— **University of Toronto, Leadership (research), June 2022**

Sustainability Integration
Program for Students

at the University of Tasmania, Australia

University of Tasmania, Australia

What is the purpose of the university living lab? The Sustainability Integration Program for Students (SIPS) initiative aims to embed sustainability in student education through applied learning on and around campus and draw on student capabilities to inform operational sustainability efforts at the University of Tasmania.

How is the university living lab organised?
The Sustainability Office has run SIPS for over 12 years alongside operational sustainability activities. Currently students are recruited for around 25 paid internships (competitive application process, 70 hours commitment), around 25 curricular placements (course credit for projects, 70 hours commitment), as well as honours, masters, and PhD research projects. SIPS aims for a diverse portfolio of projects each year while responding to unexpected opportunities related to student applicants' interests and skills.

The SIPS Coordinator manages an open call for project proposals from academic and professional staff, students, and external stakeholders (community). Project ideas also stem from university sustainability policies to inform implementation. Curriculum placements are developed with subject coordinators, while student interns present their interests and skills in the application process and are matched to appropriate projects where there is academic or professional staff capacity to mentor the student.

What are the main activities of the university living lab? While the program is project based, SIPS aims to develop continuity and relationships between individual student projects as "*a piece within a puzzle*" and "*part of a longer term journey*" by building on relevant past research findings and working with students to determine how the work will be passed on to the next student.

There are also established impact pathways for SIPS projects. Students work with the Sustainability Office to determine key stakeholders and direct how the research findings will be communicated. Student projects have informed the design of university sustainability policies – including a carbon neutral campaign leading to certification in 2016 and contributions to the waste minimisation action plan:

"many of [the university's strategic sustainability plans] have been informed by various projects that students have done. So, this is significantly contributing to the strategic direction of the university. It's also important to recognise that this is part of our business as usual operations as well. Student projects are happening at different scales, some are informing strategic plans and evaluations and others are more tangible infrastructure and service projects. So, we have projects like designing night-lighting at a bus stop or design of bike hubs, that's all critical to how the university operates"

— University of Tasmania, Senior Officer (operations), July 2022

University **Living Lab**

at the University of Manchester, UK

University of Manchester, UK

What is the purpose of the university living lab?

The University of Manchester's University Living Lab program provides students with the opportunity to gain experience for future employment by responding to an external organisation's research problem as part of their sustainability education. In turn, industry partners are able to leverage student capabilities and access new knowledge.

How is the university living lab organised?

The program is organised through a website and project database comprising project ideas put forward by industry partners already engaged with the university and managed by a single coordinator. This approach has evolved over time to enable maximum reach across the university without the need for substantial human and capital resourcing for both academics and industry partners.

"We wanted to do something that was across the whole University, and we wanted to scale so it would actually transform the way teaching and research were connected in the University. So we went through a few iterations of this model and gradually it evolved to become a bit lighter touch, more scalable […] what is the absolute least input we can get away with from external partners and academics, because then you come to something that might actually be sustainable long term and might actually be scalable"

— University of Manchester, Leadership (research), July 2022

Students can browse available projects on the website (one page overview with a paragraph description and external links) and submit expressions of interest to undertake the project as an assignment or more substantial research project. These living lab projects are also embedded in a university-wide course focused on the SDGs as part of assessment.

What are the main activities of the university living lab? Most projects focus on the local city region, with some projects put forward by international partners, and are broadly framed by the Sustainable Development Goals (SDGs). Student research reports are reviewed and provided to the industry partner, as well as being uploaded to the website. Some stand out projects directly influence decision-making in the organisation, while others have seeded larger research projects with external partners.

"the knowledge gaps they're trying to fill aren't business critical in themselves [...] sometimes they're things that the organisation would like to know about but can't justify doing itself. So they relate to core business, but they're not core business. Other times it is related to a central thing they're doing and it's just trying to get even more good stuff"

— University of Manchester, Leadership (research), July 2022

Living Lab projects, Department for Social Responsibility and Sustainability

at the University of Edinburgh, UK

University of Edinburgh, UK

What is the purpose of the university living lab?

The University of Edinburgh's Department for Social Responsibility and Sustainability (SRS) in corporate services (campus operations) oversees student-led Living Lab projects. Projects focus on improving campus operations in the context of the Sustainable Development Goals (SDGs) framework, underpinned by the university's strategic focus on experiential learning as part of its student offering.

How is the university living lab organised?

Supported by a dedicated coordinator in SRS, SRS and teaching staff propose project ideas each year and develop the project collaboratively with the student as supervisors. Students across disciplines can receive course credit for projects in the form of a research dissertation or (group) assignment. A Memorandum of Understanding is signed by the student and supervisors to provide transparency around expectations for support and project completion. The program coordinator also meets regularly with students to monitor their welfare and progress.

What are the main activities of the university living lab?

75 living lab projects were completed in the past year. Examples of research questions include (University of Edinburgh, Manager (education), August 2022):

- *"how can students be encouraged to reduce their energy use at Halls of Residence?"*

- *"would green health prescribing [green space for mental health] be something that the university should have?"*

- *"how can we improve the modern slavery monitoring and reporting throughout the university?"*

- *"how can the university embed sustainability in the curriculum?"*

Students choose how they will deliver recommendations to SRS, such as in a staff meeting, briefing document, or blog. Based on the evidence and recommendations generated, existing work by SRS may be reinforced, or SRS staff will deliberate on feasibility and make the case for implementation (potentially by other departments).

"One [SRS staff member] said that it helps them so much they almost wouldn't be as effective at their job without it. Because students are completing innovative research that staff may not have capacity to do, staff hugely value the evidence based research the students do at the University to make it a more sustainable and socially responsible organisation"

— **University of Edinburgh, Manager (education), August 2022**

Completed project outputs are made public on the university website and categorised by SDG. Some projects are conceived as a "*living lab living on*" where further research is needed and a subsequent project is established for continued exploration, potentially from a different disciplinary perspective.

3.3 Integrated campus management

A university living lab approach can involve experimentation with, and innovative utilisation and management of, campus environments and specific built, natural, and digital assets. In the context of transitions to sustainability, the campus represents a site of exploration, learning, and demonstration, as well as comprising systems and infrastructures to be improved and developed.

In some cases, the sustainability office frames the campus as a shared resource and engages and collaborates with researchers and students across disciplines as part of the campus sustainability strategy implementation. In other cases, there is a focus on generating (live) data on campus systems and making data accessible to researchers, students, and industry partners for experimentation and system optimisation.

"[…] [we have] a wealth of different assets, and different types and identities of our campuses […] we want visibility and utilisation, and we'll go out of our way to help those assets, whatever they might be, be able to be used by lecturers of any persuasion, for students of any level […] if we make it, you can use this; this is yours as well. You can interrogate it, optimise it, investigate it in whatever form you like"

— **Western Sydney University, Manager (operations), July 2022**

"[…] the digital twin, you're able to run experiments in the virtual space, which are effectively high-fidelity experiments because you've got all your data from the real world. Two ways of running those experiments. One is I suppose a standalone—okay, so what if I change the foot traffic through a building, what happens to the load on the HVAC? What happens to the load on the structure? But the other way to use the digital twin is as a feedback, so I'm actually looking at that data, and in real time I'm feeding it back into the performance of the building or the operation of the building."

— **Monash University, Leadership 1 (research), July 2022**

"[…] The board of the university has set a series of ambitions to be zero waste by 2030, energy neutral by 2030, promote biodiversity within the campus and incorporate sustainability within education. What I do is collect these questions that operational managers have about the processes, be that zero waste, and find the relevant researchers and try and connect these questions for, essentially, living lab research in terms of bigger projects or in-house consultancy in a sense where we can connect students directly to these research questions and students can work on real world problems, rather than just theory. In that way, we can utilise the knowledge within the university to solve its problems."

— **Utrecht University, Manager (operations), September 2022**

Campus Sustentável
(Sustainable Campus),

State University of Campinas, Brazil

What is the purpose of the university living lab?
The State University of Campinas (UNICAMP) in Brazil is taking a living lab approach to transition to sustainability on campus and in the wider community through collaborative and transdisciplinary problem-solving with student participation.

How is the university living lab organised?
The Sustainable Campus initiative is located in the university sustainability office under the Sustainable University Management Group (GGUS) established in 2014 as part of the university administration. Within GGUS there are six technical chambers (thematic groups) focused on water, energy, zero waste, environment, smart campus, and environment education respectively. Each committee comprises a diverse range of stakeholders: academics with relevant expertise, professional staff with responsibility over those systems on campus, and graduate and undergraduate students undertaking related research and study. These committees have "*total freedom to propose new solutions and also new projects for the university*" (State University of Campinas, Manager 1 (research), June 2022).

The university's sustainability Master Plan stipulates that projects are to be conducted using a living lab methodology as well as referring to the Sustainable Development Goals (SDGs). More broadly, the national government requirement for energy companies to invest a portion of their corporate profits in research facilitated early investment in the Sustainable Campus initiative.

What are the main activities of the university living lab?
The technical chambers deliberate on proposals to achieve consensus before identifying external and sometimes internal funding opportunities to undertake the applied research projects. These typically externally funded projects are implemented by the sustainability

State University of Campinas, Brazil

office of the university in collaboration with industry partners and local volunteers. Alongside project-based interventions, thematic groups are involved in developing strategic action plans for improved university management of key areas, including fauna and flora management, water resources management, energy resource management, smart campus management, and waste management.

The communications team within the Sustainable Campus manages the website and social media for the initiative, including dissemination of project outcomes. System data, such as campus mobility, is made available to students via an IoT platform. Knowledge translation is also occurring through collaboration with government (e.g. the development of energy management methodologies for the State Government of São Paulo) and a published book (*Sustainable Campus: a model of innovation in energy management for Latin America and the Caribbean, currently available in Portuguese and Spanish*).

Campus as a **Living Lab** For Sustainability

at the University of Toronto, Canada

University of Toronto, Canada

What is the purpose of the university living lab? The concept of a Campus as a Living Lab informs the University of Toronto's approach to collaborative research and operational sustainability with student participation.

How is the university living lab organised? This work is undertaken by the President's Advisory Committee on the Environment, Climate Change, and Sustainability appointed in 2017 with the aim of connecting and integrating academic and operational activities on campus. The committee is now co-chaired by a senior academic and the Chief Operations Officer, with a secretariat of four staff. Four sub-committees comprising a mix of academics and professional staff as well as students and alumni develop sustainability initiatives in (cross-cutting) areas of research, teaching, operations, and community engagement respectively. Approximately 20 people are appointed to the Committee and each sub-committees.

What are the main activities of the university living lab? This committee identifies and extends sustainability-related activities underway across the university to "*help people do what they're already doing, better [...] We don't run the buildings. We don't teach the courses. We don't do the research. We enable, facilitate, foster, encourage, support, initiate*" (University of Toronto, Leadership (research), June 2022). The committee builds relationships with senior management to embed sustainability in their work and crowd-sources ideas for on- and off-campus projects from a range of disciplines and in collaboration with industry partners. This facilitation includes developing research questions for student projects, and training workshops for staff and students (such as on transdisciplinary knowledge co-production and driving change in the workplace).

The initiative website hosts a public database of over 300 completed student projects categorised according to the Sustainable Development Goals (SDGs) and inventories of sustainability related curriculum, student groups, graduate programs and theses, and research units. The Committee publishes an annual report on activities and achievements.

Campuses as **Living Laboratories**

at The University of Melbourne, Australia

University of Melbourne, Australia

What is the purpose of the university living lab? Building on past and existing living lab projects, the University of Melbourne aims to systematically promote interdisciplinarity, experiential learning, and integration of sustainability research with campus operations and planning by leveraging campus assets and activities for applied sustainability research and teaching and fostering collaboration. Ultimately these efforts aim to drive innovation and sustainability action on campus and in the community.

How is the university living lab organised? The University of Melbourne Sustainability Plan establishes university living labs as one of 3 knowledge mobilisation priorities with a 2025 target that "sustainability research is integrated with campus operations and planning." The Chief Operating Officer Portfolio and Academic Divisions are responsible for implementation, and performance metrics include:

- The number of living lab projects generated and how they are structured, formalised, and curated

- Involvement of university stakeholders, including the quality and value of communities of practice developed (*e.g. "how well are they communicating, sharing information? Is it something that's quite a vibrant, self-sustaining little group of people who are collaborating? Is it something that requires a lot of external effort to kind of get people to actually meet and talk and share?"* (The University of Melbourne, Manager (operations), June 2022))

- Sustainability outcomes of projects conducted

The University Sustainability Strategy team (operations) coordinates this work by taking a research infrastructure approach to enabling experimentation:

"My role is not to say we will or won't do a particular experiment. It's to try and create that platform so that the people who are interested and motivated can come together in a semi-structured way to then do the living lab experiments or teaching and learning demonstrations or whatever it might be in a way that we can then track and report and improve on and share experiences between […] to set up some systems and processes so that collaborations between staff, professional staff, academic staff, the students, can form around these attributes [i.e. campus assets and processes]."

— **The University of Melbourne, Manager (operations), June 2022**

What are the main activities of the university living lab? Key activities include convening and matchmaking university stakeholders to develop communities of practice, and exploring living lab opportunities associated with university infrastructure, assets, and capabilities.

Existing living lab activities undertaken through the Sustainability Office include a student internship program where interns are tasked to address operational needs and challenges such as through evidence review, data collection and analysis, and practical implementation. Other less formalised activities include projects conducted through coursework, developed through collaboration between operational staff and academics. Through these engagements, operational data (e.g. campus biodiversity data) is made available to staff and students.

Above: University of Melbourne, Australia

3.4 A partnership and engagement model

A university living lab approach to external partnerships aims to address global challenges through collaborative socio-technical experimentation on and off campus. These multistakeholder partnerships have strategic benefits for universities in terms of (international) leadership and reputation, demonstrating real-world impact, and attracting research funding.

Cultivating these relationships contributes to the university becoming a trusted partner. This work can include co-design of research problems, collaborative testing of socio-technical innovations for commercialisation, and other forms of knowledge exchange.

"[...] we see constantly that industry is coming and saying, "What are you doing here? How can we get involved, how can we learn from it?" A lot of these advanced companies are developing new functionality and they have nowhere to test it, so there are lots of partnership opportunities out of that, which then provide operations opportunities to be at the leading edge of it [...] having a test bed operationally where we can push and we can rely on our academics and thought leaders to help support that, and then we've got a place where we can partner with industry to develop those solutions that often aren't currently commercial in the market."

— **Monash University, Manager 1 (operations), June 2022**

"[...] we can provide an environment that [industry partners] can't get access to otherwise"

—**Monash University, Leadership (enterprise), July 2022**

"[...] How do you engage? Are we talking sponsorship or, like in the Gothenburg example, where they actually put money in? And that's a harder sell and more difficult but that can work too. I don't know what the real answer is but that worked for us on that precinct, where we just had more sponsorship and then see which companies actually want to work with you on prototyping new products. And then see whether there's others who come in afterwards and want to do research with you."

— **Western Sydney University, Leadership (research), July 2022**

The **Green Village**

at TU Delft, The Netherlands

What is the purpose of the university living lab?

The Green Village is a field lab located in the centre of TU Delft campus that supports experimentation with end-users and residents in sustainable building and renovation, future energy systems, and climate adaptive cities. The aspiration is that early-stage innovations like those tested at the Green Village can then be tested on campus through experiments that involve end users such as students and staff, where campus operations is the client.

How is the university living lab organised?

Operated as an independent, non-profit foundation, the Green Village connects private companies with TU Delft researchers (including students) to facilitate prototype development. Over 15 paid staff (including a director and thematic program managers) and an advisory board (including TU Delft faculty representatives) select, oversee, and coordinate projects. TU Delft campus facilities provide in-kind support (such as landscaping and waste management).

Through government partnerships with the municipality, province, ministries, and water board, the site benefits from a regulatory exemption from usual building regulations to enable innovation. In turn, government partners have committed to "*be actively involved in making [the innovation] possible*" at scale by addressing institutional barriers and enablers (The Green Village, Manager (operations), June 2022).

Industry partners pay an annual service fee (approx. €50,000 per year) to undertake a project on the site which funds staff salaries and other facility costs alongside other grants, external industry investment (e.g. in prototype technology), and contributions from the university. The Green Village received approximately €4 million of seed funding (European Regional Development Fund) for the initial infrastructure set up in 2015.

Above: TU Delft, The Netherlands

What are the main activities of the university living lab? At the time of interviewing, around 70 projects were being tested on the site.

> *"I think our main, if you would call it like that, KPI, would be how fast the projects leave our site [...] it means that they have made enough progress to be able to skill up or sometimes that's also happening that they have to go back to their drawing table and of course it also happens that innovations do not succeed. Quite often actually. They still have to make other changes to be able to skill up"*

> **— The Green Village, Manager (operations), June 2022**

Through this work, the Green Village is building a learning community for education of industry professionals based on experiences and outcomes of projects, including through site visits. TU Delft campus estate managers also have the opportunity to "*shop at the Green Village to see which innovations they can actually take and implement*" (The Green Village, Manager (operations), June 2022).

> *"impact is also the fact of stopping bad innovations to go to market"*

> **— The Green Village, Manager (research), June 2022**

Above: TU Delft, The Netherlands

Ohio State **Energy Partners** (OSEP),

Ohio State University (OSU), US

Ohio State University, US

What is the purpose of the university living lab? Ohio State Energy Partners (OSEP) aims to drive sustainable energy innovation on campus and in the wider community and energy sector. OSEP provides campus energy efficient management infrastructure and services, makes facilities and data accessible for research and learning, and supports investment in research.

How is the university living lab organised?
OSEP was established in 2017 as a 50-year partnership agreement with ENGIE, North America and Axium Infrastructure and contributes to the university's carbon neutrality target by 2050. Embedded in OSU's contractual agreement with ENGIE is a 25% energy reduction target by 2027. OSEP includes a USD$150 million funding commitment for academic activities.

In parallel, the Sustainability Institute was launched in 2019 as a result of the merging of the Office of Energy and Environment (operations) and an academic unit focused on sustainability and resilience. The Institute aims to develop synergies between teaching, research, engagement, and operational goals, including through OSEP.

What are the main activities of the university living lab? OSEP has three key activities:

- Building an Energy Advancement and Innovation Center (due to open in 2023) for interdisciplinary research and technology commercialisation

- Operational deployment of smart meters on buildings, generation of data, and establishment of an accessible data platform for research and learning

- Conduct of the partnership including curriculum development, research (including provision of funding and leveraging external funding sources), and other initiatives such as student internships and competitions

Energy Research Institute
@ NTU (ERI@N)

at Nanyang Technological University (NTU), Singapore

What are the main activities of the university living lab? Living lab projects are undertaken on campus, offsite, and with third-party facilities (external) focused on technological demonstration (e.g. microgrids, electric vehicles, digital twinning). The Institute also makes campus sites available for third-party testing.

Living lab demonstration sites are made accessible through public tours as a valuable communication tool for the university's capabilities and evidence of technological solutions. Novel technologies developed on campus are also implemented on campus, such as natural cooling systems at The Hive building.

What is the purpose of the university living lab? In collaboration with industry, ERI@N aims to demonstrate the functionality of new energy technologies through real world testing towards commercialisation.

How is the university living lab organised?
Living lab initiatives undertaken through the Institute are project-based and explicitly "external facing" involving collaboration with industry stakeholders, including ENGIE. The university Sustainability Framework positions the campus as a test bed for new technologies, and the university and Institute's research strategy aligns with government policy priorities of demonstration and translational research.

The Institute secures industry and government funding for living lab projects, and rents facilities and land provided by government agencies. The Institute employs and modifies internal research models and standardised contracts for each project to cater for the diversity of industry partner profiles, including negotiation of IP.

Above: Nanyang Technological University, Singapore

"We have had companies who were not really interested in a commercialisation of certain research and they were very happy to make everything open source, it doesn't happen often, but it has happened with companies are not interested in IP [...] other companies are very strict, confidentiality especially, and especially if you try to do work with multinationals you need to be very, very flexible to make things work [...] because a lot of the local structures are set up for everything you've done in Singapore"

— **Nanyang Technological University, Leadership (research), September 2022**

4. Challenges for embedding University Living Labs

4.1 Limitations of governing structures

The most common challenge to effective implementation of university living labs identified by respondents is poor coordination of activities and stakeholders.

University living labs are often characterised as **lacking long-term strategy for coordinating activities**, including attention to strategic goals and how external funding is leveraged. In this context, respondents raised concerns about fair distribution of funds for living lab activities to support research and teaching alongside infrastructure development. There is also a need for governance structures to ensure continuity through changes in leadership and staff turnover. One respondent highlighted the challenge of defining success and determining evaluation metrics.

"[…] probably the most common thing that I see happening is that a conversation starts about a living lab project, but what ends up happening is that one area or another benefits, but the others don't. So, it might be [that] research, operations and teaching is all spoken about initially, but in the end it kind of peters off and research just benefits for example. We're not closing the loop into the operational part of the project or the teaching […] I think that governance oversight would help to ensure that all could benefit."

— **Deakin University, Manager (operations), July 2022**

"[…] We need that institutional embedding to be viable in the longer term. Because any individual, any champion, any group like our committee is temporary. It's not going to necessarily be around in five years. Get a new president, everything might change. So, it's that embedding that ensures institutional longevity in a way."

— **University of Toronto, Leadership (research), June 2022**

"[…] At the moment we do not have a scalable living lab. We either have a project-by-project approach or an approach where you need to know someone in order to be able to access the living lab. And the resources required to support that aren't scalable because they rely on individual transactions between people which you cannot serve a research community of 15,000 researchers and a student community of 80,000 students with that sort of model."

— **Monash University, Leadership (operations), June 2022**

"[…] how you know if a living lab is successful or not […] what's most educational for the student might be least useful for the university in that we often learn most from things that don't work well but you want the university operations to go well. So, defining success in a living lab, is it about educational outcomes or is it about operational outcomes? It's one of the examples of where I think there's some nuances to living labs that sometimes don't seem to be reflected in discussions I hear around them."

— **The University of Melbourne, Manager (operations), June 2022**

Because university living labs span different parts of the university, **_program ownership becomes unclear which can stall decision-making and affect buy-in_**. University-wide systems and strategies can support university living labs by directing attention and resources and establishing new governing bodies. However, centralised systems are in tension with the "distributed governance" of academic faculties as well as the expectation that innovation should be undertaken in a decentralised manner. As such, there are trade-offs associated with more or less governing authority for university living lab committees. For university living labs involving construction of built environments (such as whole buildings) challenges also arise when there is no long-term strategy for asset maintenance and use, and how to deal with legacy systems.

"[…] there are always interested academics, there are people who see innovation as a great thing. But that hasn't been managed, and people don't necessarily want that managed, or centralised, or facilitated specifically. So that's one of the problems that we came up against"

— **TU Delft, Academic, July 2022**

"[…] a living lab tends to cut across standard structures at the university. So, either everyone thinks he or she should make a decision or no one feels ownership about the topic and therefore, it's very hard to move forward with it."

— **Monash University, Leadership 3 (research), July 2022**

Other limitations in central coordinating structures include a **lack of clear and uniformly implemented systems and frameworks** for access to data, partnerships (addressing ownership, IP, pricing etc.), commercialisation pathways, and mechanisms for the university to prioritise and implement lessons and recommendations.

"[...] I think without that more formal structure, framework and governance, [monitoring, evaluation, and reporting on projects] probably won't happen. It will be up to individuals who have an interest or passion for it probably."

— **Deakin University, Manager (operations), July 2022**

"[...] People sit down and talk about it and not much happens. So if you haven't established a clear process that says, "If we come up with something and Monash or the partner or partners think that there is something that's commercialisable," if there isn't a process, then invariably it goes nowhere. The inertia of the organisations that are involved just make it generally too hard."

— **Monash University, Leadership (enterprise), July 2022**

"[...] I think the biggest barrier is that there's got to be something there to make it easy for the researchers to shape their project because if you've got a three-year grant and you're having a conversation saying, "Maybe by year two and a half we'll get you some data," it doesn't work."

— **Monash University, Manager 1 (operations), June 2022**
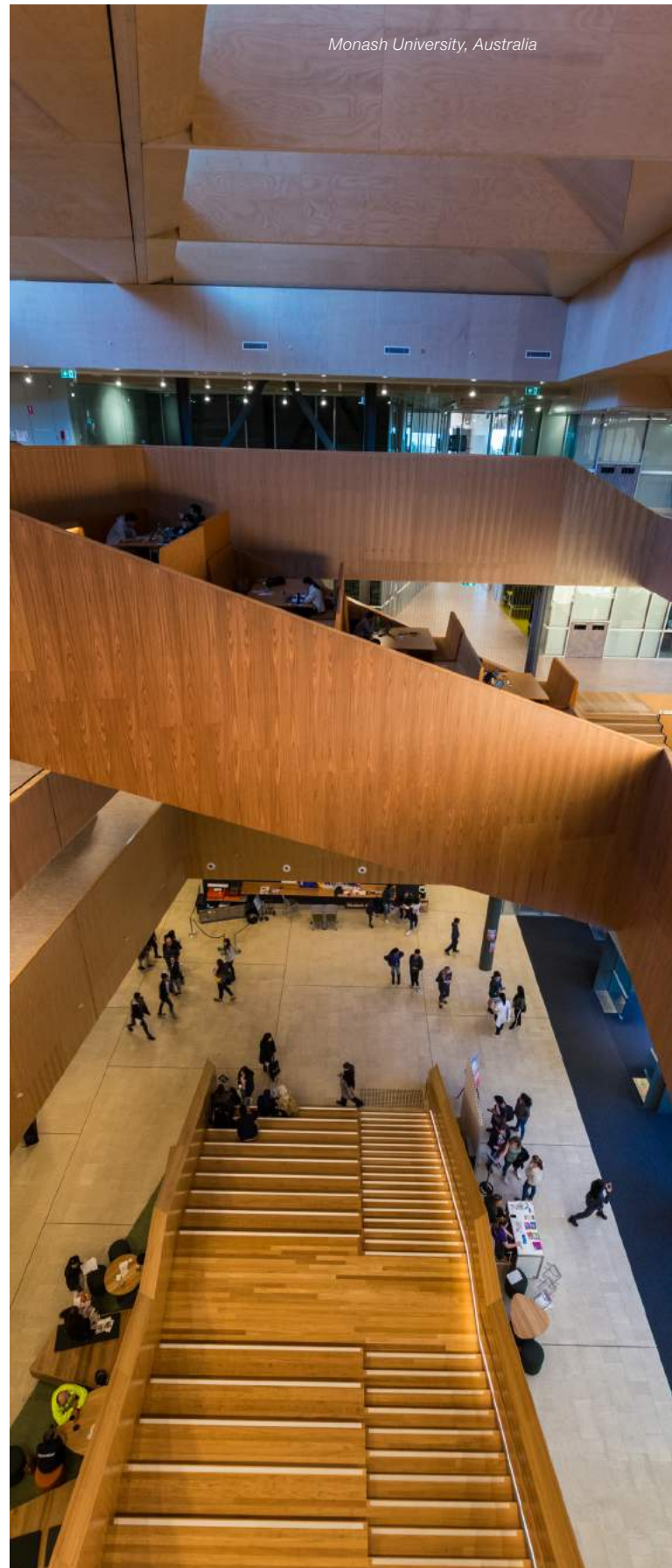
Monash University, Australia

4.2 Ad hoc and limited resourcing

All respondents accept that ad hoc and project-based funding is not enough to realise the potential of a university living lab.

Short-term and finite funding creates uncertainty, limits continuity, and focuses efforts on immediate needs. Short-termism is characterised by a lack of investment in collective infrastructures for continuation and different use cases (e.g. in research and teaching), and represents a barrier to effective program coordination and administration, monitoring and evaluation, and dissemination of outcomes. Moreover, project-based funding may limit the scope of experimentation in response to emerging questions or unforeseen developments (University of Stuttgart, Academic, July 2022). Nevertheless, funding constraints are not limited to university living lab initiatives, but rather reflect a broader challenge in higher education. For example, some significant external project funding calls have very low success rates.

"[…] the problem we had—and it's a problem a lot of places have had—is you get a tranche of money to set something up, but it's essentially project funding, so it's a lump of money for a certain period of time and then you're constantly re-applying for more money to keep the thing going. This is not a sustainable way to run something which essentially should be part of the teaching and research infrastructure."

— **University of Manchester, Leadership (research), July 2022**

"[…] we spent a lot of time responding to calls for European projects with a success rate from 1% to 2%, so it's still very low and it's true that it's not wasted work, but it can demotivate a little when you mobilise a lot of people to do a European project which is nevertheless well rated, has good grades but despite all that cannot be passed because out of 200 applications only 10 projects are selected."

— **La Rochelle University, Manager (operations) September 2022**

"[…] there are always academics out there who are keen to utilise the data, but most of them operate through the narrow lens of, "I've got this bit of data and this project that I need to deliver." Which is fair and reasonable, they've got to hit their milestones for their grants, so they find a solution and then they move on. So I think what's needed is recognising that there's lot of collective demand and effort going into this, but all of it's going to dead ends rather than collectively allowing the creation of something that can be reused."

— **Monash University, Manager 1 (operations), June 2022**

Workload and time constraints present acute challenges for university living lab initiatives as a novel approach to research, teaching, and engagement. University living lab activities are sometimes characterised as "side of the desk" work—in other words, voluntary effort in addition to staff roles and responsibilities. As such, living lab activities can be circumscribed by the availability and responsiveness of teams involved. Moreover, standardised academic performance metrics that do not adequately recognise university living lab outcomes (compared with traditional research outputs) can be a disincentive for researchers who may not see the value in spending time establishing a university living lab. In addition, without more substantial funding, university living lab initiatives seeking to cultivate community participation might rely on voluntary citizen contributions, such as time spent in workshops, which raises ethical questions around compensation for input.

"[…] Another barrier is that the researchers are struggling with the workload of handling the research and the project management of these things—they can't be both, essentially."

— **RMIT University, Manager (research), July 2022**

"[…] One other issue was that innovation and implementation of ideas costs money. And at the moment it relies on everyone's extra effort, or just taking a little bit of your research time to do this, or finding funding […] If there is no money everybody kind of runs on passion."

— **TU Delft, Academic, July 2022**

Moreover, internal university funding structures can be misaligned with living lab activities (for example, the timing of annual university budget allocation compared with the need to advertise and establish student placements) and time-consuming (such as university budget approval processes, establishing contracts, and onboarding personnel).

4.3 Siloed institutional cultures

While collaboration across disciplines and broader institutional silos of research, teaching, operations, and enterprise is at the core of a university living lab approach, achieving this collaboration in practice remains challenging due to incumbent cultural norms at universities.

Cross-sectoral and transdisciplinary collaboration is constrained by entrenched disciplinary and institutional boundaries. Managing different theoretical perspectives is an inherent challenge of transdisciplinary work. More significantly, at times university living labs prompt territorial behaviour over existing boundaries of functional units, or generate conflict in terms of ownership of facilities and activities between living lab parties. Some researchers can lack experience and knowledge regarding how to engage with professional staff at the university. Respondents also identified an assumed hierarchy of expertise between academics and professional staff (in terms of academic "ego") and professional staff's assumptions that academics are unable to operate in a real world context, which can hinder effective collaboration.

"[…] all faculty and all chairs of departments and all deans resist any kind of encroachment on their freedom to decide what matters and what to teach and what to do research on. So, that's a reality of the culture"

— **University of Toronto, Leadership (research), June 2022**

"[…] There is a mismatch in timing, finance. Operations say academics always take too long when they do stuff, academics say operations are just focused on time, on budget and within the scope, so they're not willing to take any risks."

— **TU Delft, Academic, July 2022**

Collaboration through university living labs can present risks to existing ways of working as well as practical challenges. Collaboration can be inhibited by misalignment of the academic calendar with the workflows of operations staff, and additions or changes to work plans. Similarly, traditional academic metrics are not well-aligned to transdisciplinary and applied research in terms of resourcing, outputs, and timeframes which makes this kind of work higher-risk for academics. Managing technological risk associated with experimentation with campus facilities, including data privacy and security, is particularly challenging where incumbent facilities were not designed for the purpose of research. Another respondent highlighted the challenge of managing commercial interests which may prioritise securing revenues over technological innovation in building developments. Overall, the university living lab approach requires a cultural shift to recognise the merit of applied, collaborative research as distinct from knowledge translation.

"[…] the challenge is for, say, early career faculty, it takes longer if you're involving non-academic partners in a deep way. It just inescapably takes longer, because you've got to spend time just working together. Second, you end up producing a lot of non-academic products, because that's what your partners want to have. And, third, when you do publish, it tends to be in more interdisciplinary journals, which can be lower status in various disciplinary environments."

— **University of Toronto, Leadership (research), June 2022**

"[…] People see this as a service, not as research. So, there is a cultural problem at the university. [Academics are] so used to being in charge of our own destiny, in control of the research agenda, able to define the goals – it's sort of a unidirectional model, truth speaks to power. All those kinds of concepts are still very prevalent in the university. That's one of the cultural issues, is just getting recognition that this actually counts as research and this is actually an incredibly fruitful way to do research."

— **University of Toronto, Leadership (research), June 2022**

Ohio State University, US

4.4 Lack of shared understanding

The mobilisation of diverse stakeholders on campus to participate in collaborative experimentation is often more difficult because the *"living lab" concept is novel, abstract, open to interpretation, and sometimes contested*—for example, whether experimentation is fully realised, or whether all decisions are made collectively.

"Lab" language can be alienating for some researchers, particularly in the social sciences and humanities, because of its association with technical disciplines. At the same time, having a very specific definition risks creating "insiders and outsiders." A key challenge is thus to establish a clear and inclusive institutional narrative that promotes broad engagement and buy-in.

"[…] my suspicion is that […] they either see the words 'living lab' and think it's just a bit of a buzzword or too sciency. And then they look at the actual model and just see it as simplistic.

— **University of Manchester, Leadership (research), July 2022**

"[…] We've mentioned this concept of living lab and the feedback that I've had was, as soon as you mention a lab, it sounds like it is an engineering or science project. So in some ways, I think even that terminology of living lab is skewed."

— **Monash University, Leadership 2 (research), July 2022**

A further barrier to generating awareness and interest in university living labs on campus is **limited dissemination of knowledge, outcomes, opportunities, and available resources**, as well as avenues for feedback and connecting with people. As a result, there is a risk of relying on individual champions with knowledge and understanding to initiate and maintain university living lab activities.

"[…] You just communicate it to the people who are part of your project, but the next project who actually deals with the same issue just in another topic didn't learn anything from you […] If you want to actively say that living labs is something happening on our campus, somebody who wants to start a living lab should be able to know who to phone, and where to start, and what's the bigger plan. And what do they receive support in, and what not?"

— **TU Delft, Academic, July 2022**

"[…] It's really funny we've often had more attention from outside the university, people going "Wow, you've got a really great program there". On campus people are going "What the heck's that?"

— **University of British Columbia, Leadership (operations), July 2022**

"[…] there's a marketing level awareness of it, but I'm not sure that we've actually moved down to having academics who might be researchers – who might be able to join projects or incorporate it into their research, that they really know enough about how it's set up, what's available, what they would need to do in order to access it"

— **Monash University, Leadership 4 (research), July 2022**

5. Enablers of effective University Living Lab governance

5.1 Relationships and facilitation

Relationship-building across institutional silos, disciplines, and external partnerships is critical to achieving buy-in, delivering projects, and embedding living lab approaches and activities in the day to day work of university staff, particularly in the absence of formalised governing structures.

Stakeholder relationships are instrumental in mobilising living lab champions (including through networking and other forums), securing in-kind support (e.g. from campus estate and facilities management) and external funding, and exchanging knowledge and cultivating interest (e.g. through communities of practice). These efforts include identifying strategic alignments (e.g. between university policies and research and operational interests), cultivating dialogue, active consultation, and co-defining problems and solutions. Respondents highlighted systematic approaches (e.g. via organisational charts and workshops) and organic engagements (e.g. leveraging existing contacts). Respondents also noted the value of "working with the willing" (University of Manchester, Leadership (research), July 2022) given the time and effort required to cultivate interest at the inception stage.

"[...] One thing that you shouldn't do is try to go to some specific operational area of the university, [and say], 'I have the solution, it's here, the perfect solution for your problems.' You need to build this together with all the people involved with the subject [...] Sometimes it takes one or two years to build a relationship of cooperation between the teams of professors, staff and students."

— **State University of Campinas, Manager 1 (research), June 2022**

"[...] we have 500 buildings, 10 campuses, we're like a distributed LGA [local government area], and all of the professionals dealing with our area deal with the realities, whether they're transitions to renewable energy—all the things that people look at out around our community, they also occur within our campuses."

— **Western Sydney University, Manager (operations), July 2022**

"[…] because it's sustainability, so it's everything to everyone, which can be troublesome. But equally, it means you can frame it and pitch it to almost any bit of the university. So, if you do have particularly strong contacts with one bit, or there is something that the university is suddenly throwing money at or wants quick wins on, you can probably play this into that space. Student experience, employability, business engagement, social responsibility, sustainability, teaching and learning, research – it's all of these things. So, you can be quite flexible with how you pitch it and frame it."

— **University of Manchester, Leadership (research), July 2022**

"[…] it really does come down to being able to make the connections of the people who are making those [funding and operational] decisions. There is no one decision maker; there are probably 20. And then there are probably another 200 people in that [group] that could have a veto vote if they are aware and not comfortable."

— **Ohio State Energy Partners, Manager (industry), July 2022**

An important element of establishing and expanding university living lab activities is **cultivating trust through interpersonal connections**. This process takes time, and one respondent highlighted the value of maintaining a "personal touch" (Western Sydney University, Manager (operations), July 2022) in university living lab facilitation. Influential and respected champions are valuable for relationship building and facilitation, while students can be effective integrators in projects due to their ability to communicate across disciplinary boundaries with greater ease (State University of Campinas, Manager 2 (research), June 2022).

"[...] a lot of academics that I've built a rapport with now come to me with ideas or say, 'Do you have another idea for the subject I'm running?' It just evolves from there, I make those connections and then you have a positive experience, get to know each other, and then they become familiar with your work and what you need to achieve for your job, and we can better find those synergies."

— **The University of Melbourne, Officer (operations), August 2022**

"[...] We have a form on our website that anyone can access. But, more importantly, we actively go out and talk to people about project ideas. So, we go into classes and talk with people about SIPS [Sustainability Integration Program for Students] and we invite project ideas. We go to presentations, we go to staff meetings. We send out emails to our networks and we are actively looking for projects across a range of subject areas."

— **University of Tasmania, Senior Officer (operations), July 2022**

"[...] [the committee co-chairs] are incredibly well-respected, as are all our president appointed committee members, and I think almost all of our sub-committee members [...] These are people with influence and a ton of expertise, insight, relationships [...] [the operations co-chair] knows who's doing what, what's interesting, where the challenges are He's a very charismatic guy, people like him, he can make a suggestion or share information about opportunities to explore."

— **University of Toronto, Leadership (operations), August 2022**

"[...] I think a campus living lab is based on trust and it needs time to build trust, it's very strong for it. And you can gain trust, but you can lose it as well very fast again. So it means it's an ongoing process which needs certain coordination, and it needs very good communication and interaction as well otherwise you can close some doors for a longer time than it took to open them."

— **Concordia University, Manager (research), August 2022**

5.2 Flexible coordination

An imperative for university living lab governance is to coordinate activities without stifling the emergence of and experimentation with new collaborations and ideas. While there is no best practice model or framework evident across the case studies, respondents highlight key processes and considerations through which to establish a culture and direction for a university living lab approach that can generate interest and investment.

Decision-making authority is necessary for overcoming barriers associated with incumbent institutional silos, speeding up implementation, mobilising resources, and clarifying program ownership. Some suggest establishing a living lab office or committee, while others point to opportunities to embed a living lab objective in existing university policies and structures, such as the portfolios of senior representatives, to allocate responsibility for implementation as part of their long-term strategic objectives. In many cases, such as in Utrecht, university leadership commitments to sustainability targets, objectives, and programs provide an authorising environment for embedding a university living lab approach to applied research and problem solving on campus.

"[…] setting up a decision making team that would have decision making power in saying, 'Okay, this is the way we are going ahead. I know there are other ways, but this is the way we are doing it.' Is very handy. The Dutch way of managing things is very collaborative to the point where nobody makes a decision. And in the end someone has to say, 'We are going to do that. It has certain risks, we are going to manage these risks, the risks have been identified, are known, and let's go for it.'"

— **TU Delft, Academic, July 2022**

"[…] it would just cut down, I think, on some of the timeframe of implementing these projects, if we could just say, 'This is something we need to do in order to address X goal that the university has already expressed and that the university has been working towards achieving.'"

— **Ohio State University, Leadership (research), August 2022**

"[…] University bureaucracy dictates that there's certain committees that have to happen; how often they have to happen; they have to be minuted; and certain items have to be reported. And if you can get your activity into that structure, then it kind of becomes something the University has to do."

— **University of Manchester, Leadership (research), July 2022**

"[…] traditionally, research infrastructures are seen as material infrastructures or major investment in research facilities whereas this would be […] that social infrastructure that creates the clarity and the mandates and has the resources to actually say yes or no and draw the boundaries within which these experiments can happen […] it's really a way of cutting through the standard incumbent structures at a university which are still very much disciplinary focused"

— **Monash University, Leadership 3 (research), July 2022**

A governing framework is beneficial for ***establishing visions and objectives*** to direct and mobilise activity. Part of this strategic direction includes establishing a degree of clarity around "living lab" as a concept in terms of key functions and broader outcomes, determining inclusive parameters around the types of projects and stakeholders involved (e.g. requiring collaboration between research and operations as a condition of seed funding such as in the UBC case), and leveraging and connecting existing research and action agendas.

"[…] I think my recommendation would be to find where the goals of the University in terms of decarbonisation or sustainability align with the specific researchers in terms of water or waste or carbon; and align with the operational goals of the partnership in terms of energy or carbon or other; and draw in those pieces together and those people together, along with the funding sources and organisational sources that govern them"

— **Ohio State Energy Partners, Manager (industry), July 2022**

"[…] I think first off, don't set the ambitions too high. Don't dive in too fast. Really focus on what could be the most a) visible and b) high impact lab to just really develop that proof of concept, figure out the challenges and really identify the best practices that you can employ and then you have this clear roadmap in which you can follow and evaluate."

— **Utrecht University, Manager (operations), September 2022**

"[…] it needs a clear plan, clear deliverables, and a governance group around it that is invested in it to deliver that outcome […] there needs to be that clear empowerment to do it and then the governance is there to steer it and hold it accountable"

— **Monash University, Manager 1 (operations), June 2022**

Convening and representing diverse stakeholders is central to establishing effective governance structures for university living lab activities. Coordinated consultation and engagement is important to ensure the strategic vision reflects stakeholder preferences and interests from the outset and to build trust. Respondents recognise the opportunity to provide support and visibility to areas or projects that are already active. In some cases, such as the State University of Campinas and La Rochelle University, stakeholder involvement is underpinned by a participatory ethos and culture in how ideas are generated and supported.

[…] We hosted a series of these co-creation workshops online. I think we had about eight of them, and during this process we really connected with researchers, students and people in operations to say, "How can this organisation serve you best? What is necessary for this? What are necessary factors that we have to have in order to help you either have a real world testing for your research or help solve your sustainable challenges?"

— **Utrecht University, Manager (operations), September 2022**

"[…] I think it's very important at a very, very early stage before the beginning to discuss the ideas to this task, vision, approach with all stakeholder groups, it doesn't mean all affected stakeholders, but with dedicated persons to get different perspectives together because it's always better to get their buy-in before you start the process than after you try to convince them how fantastic it is for them—if they take part they are much stronger committed to it. So what we did in Stuttgart [Technological University of Applied Sciences], before we handed in the proposal we made a couple of workshops to hear what external stakeholders would like to perform, to test, to see in such a set-up. And while translating their wishes, needs, requirements into what we can and would like to do we could really create an outstanding proposal based on this common understanding of where we want to head."

— **Concordia University, Manager (research), August 2022**

"[…] the teaching community and also the university staff were really mobilised to think "What was a Smart Campus like?" […] It was with the idea of making a collaborative project, a common project on which all the university stakeholders could give their opinion […] they really wanted all departments, all users including even students to enjoy the project […] a global approach, with a common reflection and not something top-down decided just by the president and his team"

— **La Rochelle University, Manager (operations), September 2022**

Coordination of university living labs is also understood in terms of *facilitating access to resources and supporting systems and frameworks* for a broader range of university actors. Centralised facilitation and knowledge sharing might include funding pathways, relevant protocols, industry engagement typologies, and lessons learned, as well as access to practical equipment or facilities and networking opportunities (e.g. matchmaking).

"[...] it unfortunately takes a really embedded person to be able to [take risks]. And I think that's why we need structures, as not everybody is embedded. Not everybody is going to be at the university for 25 years [...] it would be amazing if we establish a living lab office that could provide the overview and guidance on what are the steps people should follow on their own to run more living labs on campus"

— **TU Delft, Academic, July 2022**

"[...] What you're asking of users or stakeholders or clients—whatever you want to call them—might be different. And so, thinking a little about how we can have a spectrum of engagement types of living-lab questions and outputs or processes would help us to engage more meaningfully with different needs."

— **University of Toronto, Leadership (operations), August 2022**

"[...] getting the systems and processes in place to enable it to be scaled for people. Whether that be having the automated systems in place that are pulling out energy use data and making them accessible to people, having the rules of the game in terms of how do I run an experiment that's linked in with those different elements of our operations? How you actually go about funding projects where the gap between what investment we'd made operationally and the investment needed that would need research or an education or a translation objective and how you go about doing that"

— **Monash University, Leadership (operations), June 2022**

5.3 Communicating and demonstrating value

Language and narrative are important considerations for embedding a university living lab approach. Respondents emphasise the need for inclusive language and a clear value proposition to develop a shared understanding of the purpose, objectives, and intended outcomes for living lab activities.

The sustainability agenda is recognised as an enabling factor due to the general consensus around its importance. Similarly, one respondent also pointed to the value of the SDGs as an engagement tool (e.g. for promoting student living lab projects).

"[…] I would recommend jointly defining words [or] creating this mission. These words like transdisciplinary, like resilience, like sustainability, these are all these big passwords, each discipline understands something completely different and this creation of a universal language is exhausting to create but it's very important otherwise people continuously talk from [different perspectives]. And you will have some arguments […] [but] this is part of this communication to create a safe and common ground and be sure that everyone is on the same page."

— **Concordia University, Manager (research), August 2022**

"[…] I think recommendation one is to define what we are trying to do with a living lab because the challenge to date is that it's amorphous and it's never had a definition. There are some real examples of how it's working in the university at the moment. I think documenting those examples and saying, 'Here are the different faces of what a living lab can look like, here's what we want to actually achieve out of the living lab.' That's got to be the first step."

— **Monash University, Leadership (operations), June 2022**

"[…] how do you position yourself to the outside world? So is it mainly towards your municipality? Are you a living lab for research for the whole country? Are you a living lab for research for the whole continent, or global? And if so, why should we go to you and not to somebody else? So make more precise what you offer."

— **The Green Village, Manager (research), June 2022**

"[…] being clear about how you define success of the living lab, and recognising that how you define success might vary by the different stakeholders or partners in it, is an important discussion to have upfront. But there might be some things you can collectively agree, 'Yes, this is successful for all of us,' but then there are maybe secondary things that might vary."

— **The University of Melbourne, Manager (operations), June 2022**

More broadly, ***communications that build a public profile and disseminate knowledge*** help to socialise the concept and generate momentum both internally and externally. The functions, achievements, case studies, and opportunities of university living labs can be disseminated through presentations at events, workshops, newsletters, websites, and social media, as well as making built facilities open to the public for site visits and tours (e.g. the Green Village and Nanyang Technological University). At the same time, respondents recognised the need for internal communications to be honest about the limitations of previous initiatives to improve learning.

"[…] I have been working here for many years, but still major part of the university students and professors, they don't know anything about this project, about this initiative. So we have this communication team, we have website, Facebook, Instagram, all of these things, and also YouTube channel and so on, organise a lot of workshops, a lot of activities related to communication of all of these initiatives to the internal community and also to the external community"

— **State University of Campinas, Manager 1 (research), June 2022**

"[…] what very often is underestimated, the communication part to keep people updated because otherwise, they felt like, "Oh, they wanted to have knowledge from me and now they do something and get money and I'm away again." This is disappointing and a loss of trust. So it's a lot of finding the right measurement of providing information, engaging and inviting information, inviting the person as well to give insights"

— **Concordia University, Manager (research), August 2022**

"[…] This database is really powerful, because students can use it so they don't reinvent the wheel. If they're doing a project on Scope 3 emissions, they can look at all the previous Scope 3 emissions projects and build on that. But, also, it's something we can point people to and say, 'Look, 289 student projects. This is really cool. We're really doing something.' So, it's evidence, in a sense, of an emerging activity of the university."

— **University of Toronto, Leadership (research), June 2022**

"[…] just by saying we're doing a living lab, we've already received invitations from industry partners, from public policy partners to say, 'This is really interesting. Can we have a talk, can we collaborate?'"

— **Monash University, Leadership 3 (research), July 2022**

Being able to demonstrate the value and outcomes of university living labs is critical for cultivating buy-in among senior leadership and scaling up impact. It is through high level commitment to university living lab approaches and activities, including by faculty leadership, that an institutional mission can be established, more substantial resources secured, and implementation facilitated. In some contexts such as the State University of Campinas in Brazil, alignment with and buy-in from elected leadership is seen to pose more of a risk than a benefit to university living labs due to the short-term politics of election cycles. In this case, the importance of sustainability and the success of the living lab work is deliberately kept out of political discussions in the administration. In other examples, changes in university leadership can lead to more ambitious sustainability investments.

"[...] We went through three phases. Phase 1, I had a committee and no budget, no staff. After two years, or a year and half, I said to the president, 'I think we've shown some value. Can you give me a little resources?' He gave me two staff and a bit of a budget. And two years later, again, he doubled that. So, it's an incremental process of showing value and then being given more resources."

— University of Toronto, Leadership (research), June 2022

"[...] the biggest enabler or barrier is who's in charge. So, your vice-chancellor is the most important person in this conversation. If you have a very sympathetic vice-chancellor, you present – who comes in, is all into sustainability, really wants to do something quick – and you showed them this, they might bite your hand off and say, "Yes, okay, let's do it. We're going to back this big time.""

— University of Manchester, Leadership (research), July 2022

"[...] I think involving people higher up in the hierarchy from the beginning—a lot of literature about living labs is talking a lot about bottom up initiatives and we really did that, but in the end, the power structure and power dynamics does seem to be the biggest barrier."

— Utrecht University, Manager (operations), September 2022

"[...] the importance of the real world laboratory at the university should be made more clearly by the university leadership, or by the ministry, that all the departments know [...] And there you would just have a clear mandate—a clear statement from the university leadership, from the ministry, that they say, 'This is important, we have to take this in account. We have to consider their ideas, their research—because it's a good thing.'"

— University of Stuttgart, Academic, July 2022

5.4 Investment in people, systems, and capabilities

Embedding university living labs requires *strategic planning and corresponding investment and budget allocations.* The examples in this study broadly illustrate how diverse sources of internal and external funding are orchestrated in context specific and sometimes piecemeal ways to implement university living labs.

Long term planning and budgeting provides certainty and facilitates continuity and expansion of activities for greater impact. Capital investment (e.g. in buildings) through university living labs also requires long-term planning to ensure continued use and value.

"[…] But we have an approved innovation budget now that will come into play next year. So there are a lot of things going to happen […] If you got to that point where you've got money allocated to innovation and testing, then suddenly lots of questions about okay, who's going to manage what, and who gets funding – then those things get solidified. If there is no money everybody kind of runs on passion."

— **TU Delft, Academic, July 2022**

"[…] in 2019 we received a strategic allocation for five years. And that's made a huge difference, because we now have a guaranteed budget for five years and it just changes the scope of what we can do dramatically. And that strategic allocation is part of our divestment from fossil fuels and investment in sustainability […] I think that if I was going to say one thing, give your sustainability team funding and give them security. No matter the scale of what you're giving them, give them security so that they can do longer term planning. Secure long-term funding means we can plan for diversity, we can plan projects better and with a wider range of disciplines. Because in sustainability projects it's really important to have diversity in your team."

— **University of Tasmania, Senior Officer (operations), July 2022**

"[…] anything that might involve purpose-built infrastructure, making sure that there is that ongoing ownership, that it doesn't become something that is only a two or three-year thing we've invested a lot of money in, that the research interest disappears and it's left being a liability […] there needs to be some formal governance and longevity to it."

— **The University of Melbourne, Manager (operations), June 2022**

A coordinated approach to university living labs necessitates ***investment in salaried personnel and capabilities, including skills in integration and interdisciplinarity.*** Respondents involved in university living labs with dedicated coordination capacity (such as a secretariat or program manager(s)) consistently highlighted their importance in providing administrative support that enables innovation across more projects among a wider group of participants. Alongside program and project management, resources are needed for supporting systems such as partnerships development, commercialisation, data management, and communications.

"[…] [living labs emphasise] societal impact as well which you can measure in different ways, whether that's writing a newspaper article or more advanced things like making an actual impact on policies for instance but the reality is that comes with a lot of additional coordination and integration type of work"

— **Monash University, Leadership 3 (research), July 2022**

"[…] We've maintained a data scientist on our team the whole time, which seems like an odd function for a capital projects team that's largely responsible for infrastructure and energy improvements, but it's a critical field to understand how valuable your data is and protect it, as well understand the things it can tell you and the things it can't tell you."

— **Ohio State Energy Partners, Manager (industry), July 2022**

"[…] I think having a dedicated coordinator definitely helps. […] I can see the difference with the outputs in terms of the number of living lab projects that we've had, the number of new colleagues that have given it a go, because they knew I was there to support them […] It also means you then have a wider, and a broader type, a range of projects, which could then attract students from a variety of disciplines, rather than the same people doing it over and over."

— **University of Edinburgh, Manager (education), August 2022**

"[…] ideally you create a living lab [data set] that 70% of the student population and 70% of the academics get something out of"

— **Monash University, Manager 1 (operations), June 2022**

6. Recommendations for University Living Lab Governance

University living labs offer the potential to address the global challenges of our age in institutional settings that support ongoing experimentation, testing, and learning. This report demonstrates that while they exhibit common attributes and objectives, university living labs have diverse governance structures that respond to complex and uncertain environments.

With multiple pathways available to stakeholders across research, teaching, operations and engagement, university living labs benefit from collective effort among stakeholder coalitions to develop governance approaches that reflect the visions and values of their universities and social contexts.

We have identified a number of challenges to the effective embedding of university living labs that revolve around lack of coordination, short-term or limited resourcing, disciplinary or institutional boundaries, and confusion about the nature of living labs. Our research also points towards key enablers that can support implementation through relationship building, facilitating access to supporting systems, inclusive language, bold knowledge dissemination, and investment in people, systems and capabilities.

Right: Utrecht University, The Netherlands

Enablers Of Effective University Living Lab Governance
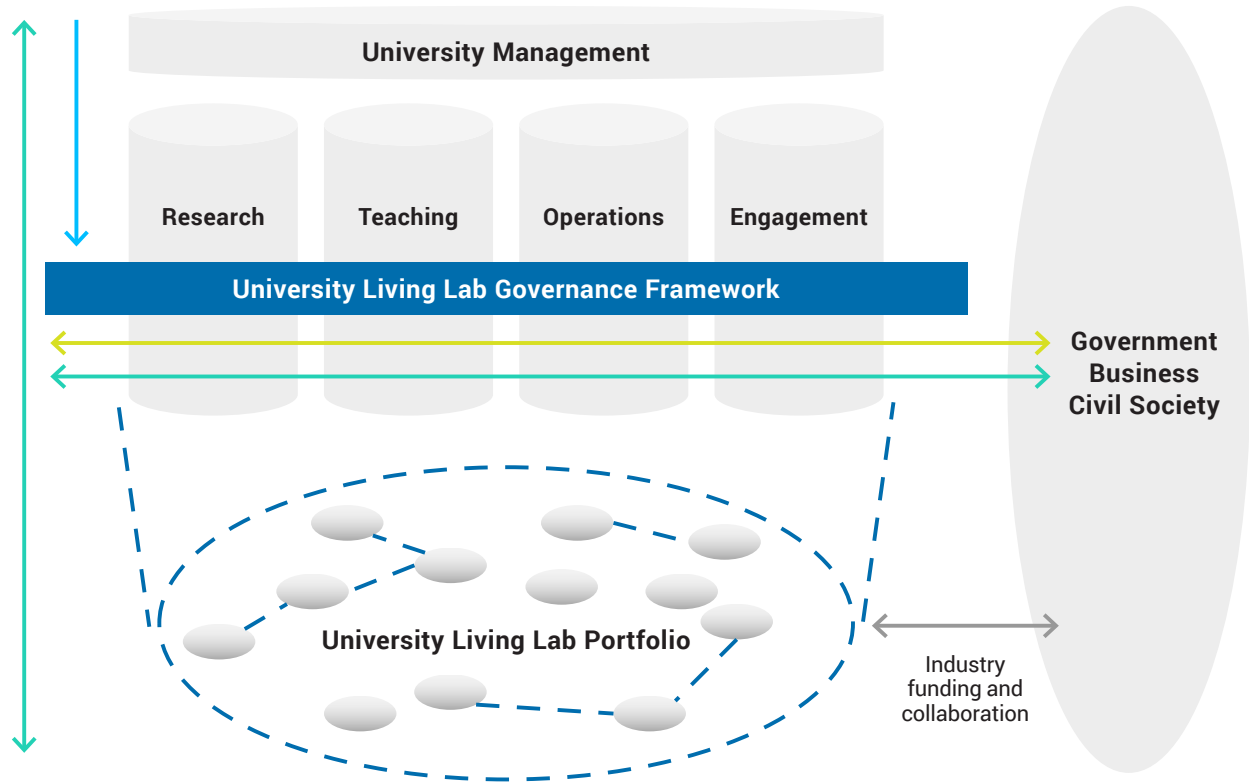
Flexible coordination	Investment	Facilitation	Communication
▪ Decision-making authority ▪ Stakeholder representation and participation ▪ Vision and objectives ▪ Make resources accessible	▪ Budget allocation for governance framework ▪ Investment in personnel and key systems	▪ Relationship building and external partnerships ▪ Interpersonal trust	▪ Disseminate knowledge ▪ Inclusive language ▪ Clear value proposition ▪ Cultivate executive buy-in

We conclude by offering academic and professional staff along with industry, government, and civil society stakeholders the following practical recommendations to advance the governance of university living labs with an interest in supporting long-term, transformative impact agendas. These recommendations contribute to the four key governance enablers identified in Section 5 and summarised in the figure above. We illustrate each recommendation in the table below with a stand out example drawn from the research.

	Recommendation	Exemplars
Flexible coordination	**Establish** a steering group with broad representation of academic and professional staff and students and a decision-making mandate to develop strategic goals, engage with university stakeholders, leverage existing programs, disseminate achievements and opportunities, and advance living lab investment and activities	The **University of Toronto's** living lab program is governed by the _President's Advisory Committee on the Environment, Climate Change, and Sustainability_, co-chaired by senior academic and professional staff with four sub-committees comprising academics, professional staff, students, and alumni, supported by a secretariat. **The State University of Campinas** _Sustainable Campus_ initiative is located in the university's sustainability office and organised around technical chambers comprising academics, professional staff, and students that develop solutions and proposals for the university.
	Identify and develop transparent and accessible toolkits, resources and processes to distribute university-wide support and connect a broad ecosystem of living lab activities across disciplines, faculties and settings	The **University of Manchester** hosts a _living lab website_ through which students, academics, and external organisations can access project reports and express interest in participating in available projects (students) or submit project ideas (organisations).
Investment	**Provide** ongoing resourcing to support a core team of university living lab program leads to communicate the vision and value proposition to different audiences and coordinate capability building in terms of skill development, facilitation support, and interdisciplinary research methods	**TU Delft** has approved a multi-million dollar "innovation budget" for the _campus real estate department_ to fund and facilitate innovations for sustainability. The **University of Tasmania** allocated strategic funding to the _Sustainability Office_ for 5 years as part of the university's divestment from fossil fuels which is supporting longer-term planning and recruitment.

Recommendation		Exemplars
Facilitation	**Develop** broad stakeholder engagement to co-design or re-imagine the internal value proposition across the university's key pillars (e.g. research, education, operations and enterprise)	*Utrecht University conducted co-creation workshops on organisational design with students, researchers, campus operations staff, and external experts to develop the university living lab governance.*
	Engage with industry and government partners and other funding bodies to co-design the external value proposition and iterate over time as circumstances change	*Ohio State University established a long-term partnership with ENGIE to provide campus energy management infrastructure and services and deliver on the university's carbon neutrality target, while making facilities and data accessible for research and learning and investing in research.*
Communication	**Develop and communicate** a broad and emergent definition of a University Living Lab based on key principles of: transdisciplinarity, university-industry collaboration, experimentation, learning-by-doing, innovation, and impact to enable inclusive and broad participation	*The **University of British Columbia** defines a living lab in terms of 1) collaboration and 2) knowledge exchange. The program is governed by a strategic vision, purpose, and mission for impact, as well as a set of core values (sustainability, equity and inclusion, transparency, collaborative learning).*
	Establish systems and metrics for impact assessment, monitoring and evaluation, communication, and dissemination of results, case studies and feedback	*The **University of Melbourne** Sustainability Plan provides an example of performance metrics for a university living lab platform including "structure, formalisation and active curation across all living labs" and demonstration of "active development and value of communities of practice."*

Appendix 1: Case study details

The table below summarises key insights for the university living lab case studies included in this research drawn from in-depth semi-structured interviews conducted from June – September 2022 (see Appendix 2 for an anonymised list of research participants) and supplemented by publicly available documentation (primarily organisation websites). Due to the time and resource limitations of the study, the database is not exhaustive and some cases are more detailed than others.

Case study and description	Focus and activities	Organisational approach	Policy framework	Funding mechanisms	Knowledge translation
Institution: Concordia University, Canada **Program:** *Living labs* **Description:** The Sustainability Hub at Concordia University is developing a university living lab for a sustainable campus and is consulting with university stakeholders via a survey and workshop series. Concordia's Next Generation Cities Institute is also developing a living lab program, bringing together researchers across disciplines and centres focused on societal challenges. In parallel, the university has convened representatives working groups of key stakeholders to develop strategic recommendations for achieving the university's mission. **Key links:** Sustainability Living lab – Sustainability Hub website Sustainability Living Lab Funding Program website Next Generation Cities Institute website Concordia University Sustainability Action Plan website Zero carbon buildings accelerator (Montreal) (article) Future Concordia working groups	**Focus:** Campus sustainability and demonstration Experiential learning Applied sustainability research with industry / community **Activities:** Student and other campus sustainability projects Applied sustainability research in collaboration with industry partners	**Coordination:** Sustainability Hub (operations) Research institute (Next Generation Cities Institute – including Canada Excellence Research Chair (CERC) in Smart, Sustainable and Resilient Cities and Communities) **Consultation and engagement:** Project-based industry partnerships	**Internal:** University sustainability action plan **External:** E.g. City of Montreal commitment to zero emission new buildings (through permit process) by 2025	**Project based:** External industry funding Internal funding scheme for student-led projects (up to CAD$80,000 available annually)	**Innovation transfer:** Aim to test and implement sustainability innovations on campus and in the city

Case study and description	Focus and activities	Organisational approach	Policy framework	Funding mechanisms	Knowledge translation
Institution: Deakin University, Australia **Program:** *Living labs* **Description:** Deakin University's Sustainability Office aims to integrate teaching and research undertaken at the university in its operational sustainability initiatives, including through external industry partnerships. Deakin's Climate Ready Campus vision for the Waurn Ponds campus explicitly employs a living lab approach to deliver sustainability on campus. **Key links:** Deakin Sustainability website Deakin Climate Ready Campus website Deakin Strategic Plan (2020) Martek et al. 2022 "Are university "living labs" able to deliver sustainable outcomes? A case-based appraisal of Deakin University, Australia"	**Focus:** Campus sustainability and demonstration **Activities:** Campus sustainability projects (e.g. a microgrid demonstration) Campus system data collection through Kinesis platform (including waste, water, energy)	**Coordination:** Sustainability office (operations) oversees projects (organised around thematic working groups) and provides access to data Research teams lead projects **Consultation and engagement:** Project-based industry partnerships	**Internal:** University sustainability strategy and strategic plan (reference to living lab approach to becoming carbon neutral by 2025 and carbon negative by 2030)	**Project based:** External research funding Industry partnership funding	**Research dissemination:** Public presentations (Sustainability Office) **Access to data:** Campus system data available to staff and students **Communications:** Climate Ready Campus video Website

Case study and description	Focus and activities	Organisational approach	Policy framework	Funding mechanisms	Knowledge translation
Institution: Delft University of Technology (TU Delft), The Netherlands **Program:** *The Green Village* and *living labs for campus sustainability* **Description:** The Green Village is an independent non-profit entity based at TU Delft that functions as a field lab. Multiple early stage technologies are tested on the site by third party organisations for an annual fee. More broadly, TU Delft is formalising a university sustainability strategy that establishes the goal for the campus to be a demonstration site for new technology. The living lab initiative is intended to function as a platform to support experimentation. **Key links:** van Wijk (2013) *Welcome to the Green Village* (Book) (EN) du Preez et al. 2022 "Campus Managers' Role in Innovation Implementation for Sustainability on Dutch University Campuses"	**Focus:** Technological demonstration with industry Campus sustainability and demonstration **Activities:** Technology prototype testing Applied sustainability research projects on campus	**Coordination:** The Green Village operates as an independent foundation with a director and project management team Advisory board mainly comprised of TU Delft academics (The Green Village) Intention to establish an accessible database for project submissions (campus real estate) Campus sustainability governing board responsible for the university sustainability strategy, with senior representation of academic, operations, and enterprise departments (newly established) **Consultation and engagement:** Project-based industry partnerships, including government (The Green Village)	**Internal:** Guidelines for project selection and use of facilities, including safety (The Green Village) University sustainability strategy (yet to be published) **External:** Regulatory exemption for experimentation in the built environment (The Green Village)	**Fee for service:** External organisations pay an annual fee for use of the Green Village site (approx. €50,000 per year per project) **Operational budget:** Innovation budget for campus sustainability (approx. €20 million – campus real estate department) **Project based:** European seed grant for establishment of facilities (Green Village) Industry investment in project testing facilities (the Green Village) External grant funds accessed by users of the Green Village	**Innovation transfer:** Technology commercialisation and policy change (The Green Village) Aim to implement new technologies in campus operations **Research dissemination:** Experiences and outcomes shared through a "learning community" of industry professionals (The Green Village)

Case study and description	Focus and activities	Organisational approach	Policy framework	Funding mechanisms	Knowledge translation
Institution: La Rochelle University, France **Program:** *Smart Campus* **Description:** Smart Campus was initiated by the President (elected in 2016) and sets out a "sandbox" approach to experimentation and transformation of the campus environment and education offerings through energy and biodiversity management, digitalisation, and social responsibility to achieve net zero carbon by 2040. **Key links:** Smart Campus website (EN) University strategy booklet (EN) La Rochelle municipality Zero Carbon Territory website (FR)	**Focus:** Campus sustainability and demonstration **Activities:** Development of university policies for sustainable development Conceptualisation and implementation of new infrastructures on campus, including: ▪ Energy efficient building renovations, smart building management with sensors, and green space provision ▪ Digitalisation, including use of digital tools for student course selection and hybrid course delivery while limiting environmental impacts Curriculum development, including: ▪ Establishing a common sustainable development education for students, encouraging voluntary action, and a course on knowledge translation and communication	**Coordination:** Two project managers: ▪ Smart Campus roadmap implementation ▪ Sustainable development and social responsibility roadmap implementation Steering committee (overseeing project implementation) Executive approval for project proposals (Vice President for Sustainable Development and Social Responsibility, Vice President Research, and the President) **Consultation and engagement:** Stakeholder consultation (defining components of the Smart Campus) Framework agreement with ENGIE (2018) to support the Smart Campus initiative	**Internal:** Sustainable development charters (university level) **External:** La Rochelle Zero Carbon Territory carbon neutral by 2040 (in which Smart Campus is a demonstration site)	**Project based:** External project funding	**Innovation transfer:** Commercialisation of living lab outcomes such as patents **Education:** Student course on knowledge translation and communication (in development)

Case study and description	Focus and activities	Organisational approach	Policy framework	Funding mechanisms	Knowledge translation
Institution: Monash University, Australia **Program:** *Net Zero Initiative* and *Net Zero Precincts project* **Description:** The Net Zero Initiative aims to achieve net zero emissions for campus operations by 2030 in concert with research, education, and translation activities across the university through a living lab approach. The Monash-ENGIE Alliance is an university-industry partnership aimed to develop net zero solutions. Net Zero Precincts is an ARC Linkage research project that contributes to the Net Zero Initiative and is underpinned by the Monash-ENGIE Alliance. The team spans Monash Buildings and Property Division, Monash Sustainable Development Institute and additional faculty expertise and engagement. **Key links:** Net Zero Initiative website Net Zero Precincts website Monash-ENGIE Alliance website Monash Sustainability Strategy Monash Impact 2030 strategic plan Sharp and Raven (2021) "Urban Planning by Experiment at Precinct Scale: Embracing Complexity, Ambiguity, and Multiplicity" Sharp et al. (2022) "A participatory approach for empowering community engagement in data governance: The Monash Net Zero Precinct"	**Focus:** Campus sustainability and demonstration **Activities:** Action-research based transition management Design anthropology research activities Aligning implementation of novel energy systems (microgrid, smart buildings, EV charging) with precinct stakeholder and community future visions Applied research (precinct transitions, energy systems, mobility, built environment, local governance, data science, transition management, design anthropology, university living lab governance and behaviour change)	**Coordination:** Program management within the university's Buildings and Property Division Living lab strategy development at executive level (Pro Vice-Chancellor Research Infrastructure) Executive steering group (initial stage) Research team-led Net Zero Precincts ARC Linkage and other living lab projects **Consultation and engagement:** Led by engagement manager (operations) and senior research officer (Monash Sustainable Development Institute) Monash-ENGIE Alliance agreement (long-term university- industry partnership)	**Internal:** University Sustainability Strategy and Net Zero Roadmap University impact strategic plan	**Operational funding:** Funding allocation for infrastructure in university capital development plan ($135 million commitment) **Project based:** Government research funding (ARC) Industry funding for research and coordination (Monash-ENGIE Alliance)	**Innovation transfer:** Commercialisation of operating models and technologies Policy recommendations **Education:** PhD student projects and industry placements Community capacity building Professional development **Research dissemination:** Conference presentations and webinars Reports Public tours **Access to data:** Extraction of operational data for teaching and research purposes

Case study and description	Focus and activities	Organisational approach	Policy framework	Funding mechanisms	Knowledge translation
Institution: Nanyang Technological University (NTU), Singapore **Program:** *Energy Research Institute @ NTU (ERI@N)* **Description:** ERI@N aims to demonstrate the functionality of new energy technologies through real world application. Living lab initiatives undertaken through the Institute are explicitly "external facing" involving collaboration with industry stakeholders, including making campus sites available for third party testing. **Key links:** Energy Research Institute @ NTU (ERI@N) website (EN) EcoCampus initiative website NTU Sustainability Framework (2021) (EN)	**Focus:** Technological demonstration with industry **Activities:** Manage multiple living lab programs: ▪ Offsite (microgrid, electric vehicles) ▪ Onsite (EcoCampus initiative, digital twinning, energy management) ▪ External living lab projects with third-party facilities	**Coordination:** Research institute (with management and scientific advisory boards) Approval of on-campus testing by facilities department **Consultation and engagement:** Project-based industry partnerships	**Internal:** University sustainability framework (referring to campus as a test bed) and sustainability targets (including reduced energy consumption and emissions, water, waste) University / Institute research strategy (in line with national government policy priorities) **External:** Singapore Government Research Innovation Enterprise (RIE) policy priorities and funding mechanism	**Project based:** External project funding (industry and government) Rent paid for facilities/land provided by government agencies to operate as a living lab	**Innovation transfer:** Commercialisation of new energy technologies **Research dissemination:** Public tours of living lab sites (including researchers, policymakers, international delegations, schools, conference-based tours)

Case study and description	Focus and activities	Organisational approach	Policy framework	Funding mechanisms	Knowledge translation
Institution: Ohio State University, US **Program:** *Ohio State Energy Partners (OSEP)* **Description:** OSEP is a 50-year partnership between Ohio State University and ENGIE North America and Axium Infrastructure established in 2017 to implement smart energy systems, establish an interdisciplinary centre for research and technology commercialisation, and fund other academic and student activities. The partnership contributes to the university's carbon neutrality and sustainability commitments. **Key links:** OSEP website Energy Advancement and Innovation Center Ohio State University Sustainability Institute website Ohio State Sustainability Goals (2015)	**Focus:** Technological demonstration with industry Campus sustainability and demonstration **Activities:** Applied research and technology commercialisation Implementation of new energy technologies in campus facilities Academic activities including curriculum development, research, student internships and competitions	**Coordination:** OSEP partnership management Sustainability Institute (11 staff) drives initiatives across teaching, research, engagement, and operations in line with the university mission High level strategic direction provided by President and Provost's Council on Sustainability **Consultation and engagement:** Sustainability Institute engages affiliated faculty (over 300) and curriculum advisors across the university	**Internal:** University sustainability goals (carbon neutral by 2050) Partnership agreement (includes 25% energy reduction target by 2027)	**Endowment:** USD$150 million funding commitment for academic activities through OSEP	**Education:** Curriculum development **Access to data:** Operational data available for research and teaching via platform **Communications:** Website

Case study and description	Focus and activities	Organisational approach	Policy framework	Funding mechanisms	Knowledge translation
Institution: RMIT University, Australia **Program:** *IC³P* **Description:** IC³P is an applied research platform focused on climate resilience and climate change adaptation through a series of living labs. Researchers collaborate with and develop outputs for professional staff at the university, as well as industry partners. This work is generating evidence, developing expertise, and contributing to the university's climate change adaptation plan. Based on initial short-term funding, the aim is to expand the program. **Key links:** IC³P website RMIT carbon (2022) and climate adaptation (2020) plans RMIT University strategy (2022)	**Focus:** Interdisciplinary sustainability research Campus sustainability and demonstration **Activities:** Collaborative research programs (spanning technological / physical and social / governance questions) Testing technological interventions on campus facilities	**Coordination:** Project management by operational team (manager, enterprise manager, project officer, communications officer) 3 senior research leads for each domain (circular economy, climate resilience, clean energy) and corresponding research teams (staff and post-graduate students) Sub-theme research streams (work packages) **Consultation and engagement:** Project based industry collaborations	**Internal:** University climate change plans **External:** Reference to the SDGs (university strategy)	**Project based:** Government research funding (including Victorian Government COVID-19 recovery fund)	**Communications:** Website Mailing list

Case study and description	Focus and activities	Organisational approach	Policy framework	Funding mechanisms	Knowledge translation
Institution: State University of Campinas, Brazil **Program:** *Campus Sustentável (Sustainable Campus)* **Description:** The Sustainable Campus initiative aims to transform the State University of Campinas campus environment through collaborative problem solving involving academics, professional staff, students, and community actors. With a particular focus on energy management, the initiative is underpinned by industry partnerships (CPFL Energia and ANEEL – the National Electric Energy Agency) and comprises a series of sub-projects. **Key links:** Sustainable Campus website (EN) da Silva et al. (2018) "Sustainable Campus Model at the University of Campinas—Brazil: An Integrated Living Lab for Renewable Generation, Electric Mobility, Energy Efficiency, Monitoring and Energy Demand Management" Yasuoka et al. (2022) "IoT solution for energy management and efficiency on a Brazilian university campus – a case study"	**Focus:** Campus sustainability and demonstration Experiential learning **Activities:** Development and implementation of applied research and development projects on campus University environment policy development	**Coordination:** Sustainable University Management Group (GGUS) within the Sustainability Office of the university administration 6 technical chambers/committees within GGUS (water, energy, zero waste, environment, smart campus, environment education) comprising academics, professional staff, and students **Consultation and engagement:** Industry partnerships (campus energy management and R&D)	**Internal:** University sustainability Master Plan (refers to living lab methodology for conducting projects) Strategic action plans (fauna and flora, water, energy, intelligent campus, waste) **External:** National government policy requiring energy corporations to invest in R&D Reference to the SDGs (project level)	**Project based:** External industry project funding Partnership R&D investment (BRL R$9.5 million)	**Innovation transfer:** Development of energy management methodologies for the State Government of São Paulo **Education:** Professional development **Research dissemination:** Published book: *Sustainable Campus: a model of innovation in energy management for Latin America and the Caribbean* (Portuguese/Spanish) **Access to data:** IoT platform (including mobility data) available for students **Communications:** Website and social media managed by Sustainable Campus communication team

Case study and description	Focus and activities	Organisational approach	Policy framework	Funding mechanisms	Knowledge translation
Institution: University of British Columbia, Canada **Program:** *Campus as a Living Lab (CLL)* **Description:** The University of British Columbia takes a living lab approach to applied research and demonstration of sustainable innovation on campus in response to global challenges. The CLL steering committee within the university executive administration represents academic and operations staff and oversees collaborative, interdisciplinary seed projects, community-based initiatives, and larger campus demonstration projects. **Key links:** Campus as a Living Lab website Robinson et al. (2013) "Next generation sustainability at The University of British Columbia: the university as societal test-bed for sustainability" Munro et al. (2016) "Combining forces: Fostering sustainability collaboration between the city of Vancouver and the University of British Columbia" Pilon et al. (2020) "Campus as a Living Lab: Creating a Culture of Research and Learning in Sustainable Development" Save et al. (2021) "Evaluation and Lessons Learned from a Campus as a Living Lab Program to Promote Sustainable Practices"	**Focus:** Campus sustainability and demonstration **Activities:** Annual seed fund competition (projects involving academic and operational staff partnerships) Campus demonstration projects (e.g. larger-scale technology initiatives) Community-based projects	**Coordination:** Program management by the Sustainability Hub (director, research manager, and program assistant) Campus as a Living Lab (CLL) Steering Committee (provides governance and oversight under the Executive Steering Committee) CLL Committee co-chairs representing research and operations **Consultation and engagement:** Industry partnerships and representation (projects)	**Internal:** University Strategic Plan (refers to role of Campus as a Living Lab approach in meeting sustainability objectives) Terms of Reference (Committee) Living lab strategic framework (vision, purpose, mission, values) **External:** Reference to the SDGs (project level)	**Project based:** Competitive seed funding (internal, annual budget CAD$200,000 for approx. 4 projects) Government grant funding Industry partner funding In-kind industry donations (e.g. provision of equipment)	**Innovation transfer:** Technology commercialisation Implementation of innovations and recommendations in campus operations **Research dissemination:** Database of funded projects and sustainability research and innovation case studies **Access to data:** Use of campus operations data for research **Communications:** Website

Case study and description	Focus and activities	Organisational approach	Policy framework	Funding mechanisms	Knowledge translation
Institution: University of Edinburgh, UK **Program:** *Living Lab projects* **Description:** The University of Edinburgh's Department for Social Responsibility and Sustainability (SRS) in corporate services oversees student-led applied research projects. Projects focus on improving campus operations in the context of the SDGs framework across a range of disciplines and earn students course credits. **Key links:** Living Lab projects website University social responsibility and sustainability strategies (2020) University Strategy 2030 Graczyk (2015) "Embedding a Living Lab approach at the University of Edinburgh" (master's thesis) Cooper and Gorman (2018) "A Holistic Approach to Embedding Social Responsibility and Sustainability in a University—Fostering Collaboration Between Researchers, Students and Operations"	**Focus:** Experiential learning **Activities:** Student research projects (individual and group) focused on sustainability	**Coordination:** Program coordinator located in the Department for Social Responsibility and Sustainability (SRS) (corporate services) **Consultation and engagement:** Annual call for project proposals among SRS staff	**Internal:** University social responsibility and sustainability strategies and overarching university strategy Memorandum of Understanding signed by student and supervisors (project expectations) **External:** Reference to the SDGs (project level)	**Operational funding:** Program coordinator salary	**Research dissemination:** Presentation of student findings and recommendations to key campus stakeholders Database of research outputs **Communications:** Website

Case study and description	Focus and activities	Organisational approach	Policy framework	Funding mechanisms	Knowledge translation
Institution: University of Manchester, UK **Program:** *University Living Lab* **Description:** The University of Manchester's University Living Lab program involves student research on sustainability challenges defined by industry partners, aligned with the SDGs. Students can search and apply for available projects via the living lab website. Students can undertake projects as part of their coursework or graduate research. Some projects lead to larger research grants. **Key links:** University Living Lab website University-wide course on SDGs University social responsibility and civic engagement plan University environmental sustainability strategy Evans et al. (2015) "Living labs and co-production : university campuses as platforms for sustainability science"	**Focus:** Experiential learning **Activities:** Applied student research projects focused on community sustainability (including course assessment)	**Coordination:** Program coordinated by academic lead for university sustainability **Consultation and engagement:** Invitation for project proposals from industry partners (existing relationships and via website)	**Internal:** University social responsibility and sustainability strategies **External:** Reference to the SDGs (project level)	**Operational funding:** Support for program coordination through the university sustainability and central teaching and learning departments	**Education:** Course on SDGs **Research dissemination:** Presentation of student findings and recommendations to industry stakeholders Database of research outputs on website **Communications:** Website

Case study and description	Focus and activities	Organisational approach	Policy framework	Funding mechanisms	Knowledge translation
Institution: The University of Melbourne, Australia **Program:** *Campuses as living laboratories* **Description:** Living labs are a strategic priority for the university in the context of sustainability to systematically promote interdisciplinarity, experiential learning, and integration of sustainability research with campus operations and planning through collaboration. This initiative focuses on physical and virtual campus systems and resources, building on previous living lab projects. **Key links:** Sustainability Plan 2030 (2022) Sustainability at Melbourne website Sustainability Internships website	**Focus:** Campus sustainability and demonstration Experiential learning **Activities:** Convening and matchmaking university stakeholders Exploring living lab opportunities associated with university infrastructure, assets, and capabilities Implementing sustainability measures and applied research on campus (including student coursework projects)	**Coordination:** Sustainability Strategy Team (operations) – the Chief Operating Officer Portfolio and Academic Divisions are responsible for implementation Student internship program (Sustainability team – approx. 5 interns appointed each semester for approx. 100 hours for course credit) **Consultation and engagement:** Development of communities of practice (students, academics, professional staff)	**Internal:** Sustainability Plan 2030 (refers to "Campuses as living laboratories" as one of 3 knowledge mobilisation priorities)	**Internal:** Aim to embed living labs in the existing funding landscape	**Innovation transfer:** Strategic aim to "catalyse action in others" **Education:** Applied research opportunities as part of student curriculum **Access to data:** E.g.campus biodiversity data for student coursework, public database of campus biodiversity **Communications:** Website, social media, newsletter (Sustainability team)

Case study and description	Focus and activities	Organisational approach	Policy framework	Funding mechanisms	Knowledge translation
Institution: University of Stuttgart, Germany **Program:** *CampUS hoch i (Real-World Laboratory)* **Description:** CampUS hoch i is a 3-year living lab funded by the Baden-Württemberg state government and involves applied research and experimentation on decarbonising the campus built environment towards carbon neutrality by 2030. Industry partners on the project include ENGIE and the City of Stuttgart. **Key links:** CampUS hoch i website (EN) ZIRIUS website (EN) The Green Office website (EN) Baden-Württemberg state government climate policy overview (EN)	**Focus:** Campus sustainability and demonstration **Activities:** Applied research and renovation of two campus buildings (energy efficiency and smart systems) Communication and engagement with university stakeholders on climate action (including a behaviour change campaign) Defining principles for achieving a climate neutral campus	**Coordination:** Led by cross-faculty research centre (ZIRIUS – Centre for Interdisciplinary Risk and Innovation Studies) interfacing with: ▪ 3 research institutes (IER, IGTE, IWB) ▪ The Green Office (established in 2021 under the university executive (research and teaching) following a student campaign, composed of staff and students) Project coordinator (based at IER – Institute of Energy Economics and Rational Energy Use) Activity-based working groups Collaboration with the university building office **Consultation and engagement:** Ideation through surveys (of students and academics), workshops, student hackathon Project-based industry partnerships (10) Expert advice accessed through the Baden-Württemberg living lab program	**Internal:** University carbon neutrality roadmap to 2030 (in development) **External:** Baden-Württemberg state government Climate Protection Act (amended 2021) – directive for universities to be carbon neutral by 2030 (note state owns university buildings) State government funding scheme for climate action by cities and universities	**Project based:** State government research funding **Operational funding:** 3-year funding for the Green Office	**Research dissemination:** Public pavilion (presenting climate action research and innovation materials and methods for students, academics, and the public) Panel discussions **Communications:** Campus climate barometer (displaying progress towards carbon neutral campus)

Case study and description	Focus and activities	Organisational approach	Policy framework	Funding mechanisms	Knowledge translation
Institution: University of Tasmania, Australia **Program:** *Sustainability Integration Program for Students (SIPS)* **Description:** SIPS is an applied sustainability education and learning initiative run by the University of Tasmania's Sustainability Office. The program involves paid student internships, curricular placements, and research projects focused on and around campus grounds. Projects are developed in collaboration with academics, professional staff, students, and external stakeholders and have informed the design of university sustainability policies. **Key links:** SIPS website Completed SIPS projects 2019-2021 University of Tasmania Sustainability Policy and Strategic Framework	**Focus:** Experiential learning Campus sustainability and demonstration **Activities:** Student projects involving applied research and coursework, and practical activities (professional placements) across a breadth of sustainability challenges	**Coordination:** SIPS coordinator based in the Sustainability Office (operations) Student internship/placement program with approx. 25 paid internships (70 hours), 25 curricular placements (70 hours), and research projects each year **Consultation and engagement:** Open call for project proposals from academics, professional staff, students, and external stakeholders	**Internal:** University Sustainability Policy and Strategic Framework	**Operational funding:** University budget commitment for Sustainability Office and paid internships	**Innovation transfer:** University policy development (based on lessons and evidence from student projects) **Research dissemination:** Presentation of student projects to key internal and external stakeholders (including in written form)

Case study and description	Focus and activities	Organisational approach	Policy framework	Funding mechanisms	Knowledge translation
Institution: University of Toronto, Canada **Program:** *Campus as a Living Lab* **Description:** The University of Toronto's approach to integrated operational sustainability, research, and impact is informed by the living lab concept with a focus on real-world student learning. Student projects on and off campus are undertaken through coursework, alongside other campus sustainability initiatives that promote interdisciplinary collaboration across research and operations. The program is governed by an executive committee. **Key links:** Campus as a Living Lab website Student project database Campus as a Living Lab course website University sustainability framework	**Focus:** Campus sustainability and demonstration Experiential learning **Activities:** Applied student research projects focused on sustainability on and off campus, primarily embedded in coursework Facilitation of other campus sustainability initiatives	**Coordination:** President's Advisory Committee on the Environment, Climate Change, and Sustainability Committee co-chairs representing research and operations Four sub-committees (research, teaching, operations, community engagement) Secretariat (four staff) – coordination, internal tracking and inventories (activities, achievements) **Consultation and engagement:** Open invitation for sustainability projects from campus practitioners, researchers, and industry partners	**Internal:** University sustainability framework **External:** Reference to the SDGs (university policy and project level)	**Project based:** Awards (approx. CAD$50,000 annual budget to recognise projects and activities identified as having living lab values) Internal grant funding (including through the Climate Positive Energy Initiative)	**Education:** Campus as a Living Lab curriculum Academic professional development workshops (e.g. transdisciplinary research methodology) **Research dissemination:** Public database of completed student projects **Communications:** Website

Case study and description	Focus and activities	Organisational approach	Policy framework	Funding mechanisms	Knowledge translation
Institution: Utrecht University, The Netherlands **Program:** *Living Labs for Sustainable Development (UULabs)* **Description:** UULabs aims to facilitate co-creation and experimentation on campus towards achieving the university's sustainability objectives by connecting research, education, and operations. UULabs is situated in the sustainability program of the campus real estate and facilities departments. The UULabs strategy was informed by workshops with academic and operational staff in 2021. This initiative was preceded by the Green Office Living Lab program which focused on student projects. **Key links:** Utrecht University Living Labs website (EN) ▪ Living lab model and operating principles ▪ Living lab project database ▪ Campus map of living lab projects Green Office Student Living Lab Research archive University Strategic Plan (EN)	**Focus:** Campus sustainability and demonstration **Activities:** 3 flagship campus projects: ▪ Solar Ecology Meadow – integrating land use for livestock and solar energy generation to understand impacts on biodiversity and livestock ▪ Air quality monitoring – collecting data on air quality and mobility to inform healthy campus redevelopment ▪ Waste management and circular economy – understanding waste flows to achieve zero waste on campus Facilitation of new project development Student research (through coursework and theses)	**Coordination:** Orchestration team: ▪ Program manager ▪ Communications manager (part time) ▪ Expert advisor ▪ Research and administration interns Living lab advisory board: ▪ 2 student representatives (involved in the university council) ▪ 2 operations representatives ▪ 2 research representatives **Consultation and engagement:** Co-creation workshop series with students, researchers, campus operations staff, and external experts on organisational design Stakeholder network ambassadors (including researchers across departments and disciplines, and operations representatives) Project-level industry partnerships (provision of products and services) and research collaborations	**Internal:** University Strategic Plan (strategic theme "Pathways to Sustainability" and a commitment to establishing testing grounds for sustainable innovation on campus) University sustainability program and targets (including zero waste and energy neutral by 2030, promoting biodiversity) Living lab operating principles guiding project selection (including: 1) user-centred, open, real life and transdisciplinary experimentation, 2) alignment with university sustainability ambitions and 3) the SDGs, 4) experiential learning, and 5) transformation of university culture) **External:** Reference to the SDGs (project level)	**Operational funding:** Central university budget (management and operations personnel salaries overseeing projects) **Other:** PhD scholarship (focused on living lab methodology)	**Research dissemination:** Public database and campus map of living lab projects **Communications:** Website

Case study and description	Focus and activities	Organisational approach	Policy framework	Funding mechanisms	Knowledge translation
Institution: Western Sydney University, Australia **Program:** *Living Labs* **Description:** The Environmental Sustainability team within the Office of Estate and Commercial at Western Sydney University employs a Living Lab approach to stakeholder engagement on campus as a core part of achieving sustainable campus operations. The sustainability office enables academics and students to access a range of campus assets and sites for interdisciplinary research and experiential learning opportunities, including through externally funded projects and industry collaborations. **Key links:** Living Labs website Western Sydney University Environmental Sustainability Action Plan Western Sydney University Sustainability and Resilience 2030 strategy	**Focus:** Campus sustainability and demonstration Experiential learning **Activities:** Range of applied sustainability research projects attached to assets and environments across Western Sydney campuses (including social and conservation studies of campus biodiversity, regenerative commercial farming, solar PV car park engineering experiment)	**Coordination:** Environmental Sustainability team (Office of Estate and Commercial) responsible for implementing Environmental Sustainability Action Plan Research teams (larger projects) **Consultation and engagement:** Living lab engagement approach to stakeholder outreach and relationship building (sustainability office) Industry partnerships	**Internal:** University sustainability strategy University environmental sustainability action plan (refers to living lab approach to strategic engagement) **External:** Reference to the SDGs (university sustainability strategy)	**Operational budget:** Sustainability office staff (3 core staff and a data manager) Small amounts of funding available for purchase of equipment for projects **Project based funding:** External research grants and industry funding	**Communications:** Campus redevelopment campaigns

Appendix 2: Research participants

Institution	Role	Date
Concordia University, Canada	Manager (research)	2 August 2022
Deakin University, Australia	Manager (operations)	1 July 2022
La Rochelle University, France	Leadership (research)	14 September 2022
La Rochelle University, France	Manager (operations)	22 September 2022
Monash University, Australia	Leadership (operations)	23 June 2022
Monash University, Australia	Manager 1 (operations)	29 June 2022
Monash University, Australia	Manager 2 (operations)	4 July 2022
Monash University, Australia	Leadership 1 (research)	6 July 2022
Monash University, Australia	Leadership 2 (research)	11 July 2022
Monash University, Australia	Leadership (enterprise)	13 July 2022
Monash University, Australia	Leadership 3 (research)	18 July 2022
Monash University, Australia	Leadership 4 (research)	21 July 2022
Monash University, Australia	Manager (research)	22 August 2022
Nanyang Technology ical University, Singapore	Leadership (research)	30 September 2022
Ohio State Energy Partners (OSEP) / ENGIE (Ohio), US	Manager (industry)	26 July 2022
Ohio State University, US	Leadership (research)	11 August 2022
RMIT University, Australia	Manager (research)	12 July 2022
RMIT University, Australia	Academic	12 July 2022
RMIT University, Australia	Leadership (research)	12 July 2022
State University of Campinas, Brazil	Manager 1 (research)	24 June 2022
State University of Campinas, Brazil	Manager 2 (research)	30 June 2022
The Green Village, The Netherlands	Manager (operations)	21 June 2022
The Green Village, The Netherlands	Manager (research)	22 June 2022
TU Delft, The Netherlands	Academic	13 July 2022
TU Delft, The Netherlands	Manager (operations)	19 July 2022
University of British Columbia, Canada	Leadership (operations)	20 July 2022
University of British Columbia, Canada	Manager (enterprise)	20 July 2022

Institution	Role	Date
University of Edinburgh, UK	Manager (education)	3 August 2022
University of Manchester, UK	Leadership (research)	13 July 2022
University of Melbourne, Australia	Manager (operations)	28 June 2022
University of Melbourne, Australia	Officer (operations)	2 August 2022
University of Stuttgart	Academic	11 July 2022
University of Stuttgart	Manager (research)	28 July 2022
University of Tasmania, Australia	Senior Officer (operations)	26 July 2022
University of Toronto, Canada	Leadership (research)	28 June 2022
University of Toronto, Canada	Leadership (operations)	5 August 2022
Utrecht University, The Netherlands	Manager (operations)	21 September 2022
Western Sydney University, Australia	Manager (operations)	14 July 2022
Western Sydney University, Australia	Leadership (research)	29 July 2022

Endnotes

[1]Robinson et al. 2013; Verhoef and Bossert 2019

[2]Sharp and Raven 2021

[3]Torrens and von Wirth 2021

[4]Bergmann et al. 2021; Cooper and Gorman 2018; du Preez et al. 2022; Evans et al. 2015; Martek et al. 2022; Save et al. 2021; Tercanli and Jongboed 2022; van Geenhuizen, 2013; Wiek et al. 2017

[5]Engle et al. 2022; Higgins & Klein 2011

References

Bergmann, M., Schäpke, N., Marg, O., Stelzer, F., Lang, D. J., Bossert, M., Gantert, M., Häußler, E., Marquardt, E., Piontek, F. M., Potthast, T., Rhodius, R., Rudolph, M., Ruddat, M., Seebacher, A., & Sußmann, N. (2021). Transdisciplinary sustainability research in real-world labs: Success factors and methods for change. *Sustainability Science*, *16*(2), 541–564. https://doi.org/10.1007/s11625-020-00886-8

Botero, L., Bossert, M., Eicker, U., Cremers, J., Palla, N., & Schoch, C. (2017). A Real-World Lab Approach to the Carbon Neutral Campus Transition: A Case Study. In W. Leal Filho, M. Mifsud, C. Shiel, & R. Pretorius (Eds.), *Handbook of Theory and Practice of Sustainable Development in Higher Education* (pp. 73–88). Springer International Publishing. https://doi.org/10.1007/978-3-319-47895-1_5

Brugmann, R., Côté, N., Postma, N., Shaw, E. A., Pal, D., & Robinson, J. B. (2019). Expanding Student Engagement in Sustainability: Using SDG- and CEL-Focused Inventories to Transform Curriculum at the University of Toronto. *Sustainability*, *11*(2), Article 2. https://doi.org/10.3390/su11020530

Burbridge, M., & Morrison, G. M. (2021). A Systematic Literature Review of Partnership Development at the University–Industry–Government Nexus. *Sustainability*. https://doi.org/10.3390/su132413780

Cai, X., White, M., Shafiee-Jood, M., & Pereira, J. (2017). *Overviews of Campus Sustainability Projects at Illinois: Opportunities for Education and Research.* Institute for Sustainability, Energy, and Environment (iSEE). https://sustainability.illinois.edu/wp-content/uploads/2018/02/Overview-of-CS-Projects.pdf

Callaghan, R., & Herselman, M. (2015). Applying a Living Lab methodology to support innovation in education at a university in South Africa. *The Journal for Transdisciplinary Research in Southern Africa*, *11*(1), 18. https://doi.org/10.4102/td.v11i1.30

Cooper, L., & Gorman, D. (2018). A Holistic Approach to Embedding Social Responsibility and Sustainability in a University—Fostering Collaboration Between Researchers, Students and Operations. In W. Leal Filho (Ed.), *Handbook of Sustainability Science and Research* (pp. 177–192). Springer International Publishing. https://doi.org/10.1007/978-3-319-63007-6_11

da Silva, L. C. P., Villalva, M. G., de Almeida, M. C., Brittes, J. L. P., Yasuoka, J., Cypriano, J. G. I., Dotta, D., Pereira, J. T. V., Salles, M. B. C., Archilli, G. B., & Campos, J. G. (2018). Sustainable Campus Model at the University of Campinas—Brazil: An Integrated Living Lab for Renewable Generation, Electric Mobility, Energy Efficiency, Monitoring and Energy Demand Management. In W. Leal Filho, F. Frankenberger, P. Iglecias, & R. C. K. Mülfarth (Eds.), *Towards Green Campus Operations* (pp. 457–472). Springer, Cham. https://doi.org/10.1007/978-3-319-76885-4_30

du Preez, M., Arkesteijn, M. H., den Heijer, A. C., & Rymarzak, M. (2022). Campus Managers' Role in Innovation Implementation for Sustainability on Dutch University Campuses. *Sustainability*, *14*(23), Article 23. https://doi.org/10.3390/su142316251

Engle, J., Britton, T., & Glode-Desrochers, P. (2022). Social Infrastructure for Our Times: Building Participatory Systems that Value the Creativity of Everyone. In *Sacred Civics: Building Seven Generation Cities* (149-165). Routledge. http://doi.org/10.4324/9781003199816-15

Evans, J., Jones, R., Karvonen, A., Millard, L., & Wendler, J. (2015). Living labs and co-production: University campuses as platforms for sustainability science. *Current Opinion in Environmental Sustainability*, *16*, 1–6. https://doi.org/10.1016/j.cosust.2015.06.005

Favaloro, T., Ball, T., & Lipschutz, R. D. (2019). Mind the Gap! Developing the Campus as a Living Lab for Student Experiential Learning in Sustainability. In W. Leal Filho & U. Bardi (Eds.), *Sustainability on University Campuses: Learning, Skills Building and Best Practices* (pp. 91–113). Springer International Publishing. https://doi.org/10.1007/978-3-030-15864-4_7

Graczyk, P. (2015). *Embedding a Living Lab approach at the University of Edinburgh*. [Master's Thesis, The University of Edinburgh]. The University of Edinburgh. https://www.ed.ac.uk/files/atoms/files/embedding_a_living_lab_approach_at_the_university_of_edinburgh.pdf

Gunnels, C. W., Abercrombie, M. I., Bovard, B. D., Croshaw, D. A., Drummond, J., Everham III, E. M., Hancock, T., Herman, J., Jackueux, M., Lefevre, K. L., Marcolini, J. P., McConnell, V., Metcalf, M., Sanchez, I. L., Thomas, S., Walsh-Haney, H., & Voytek, M. (2021). Campus as a Living Laboratory: Conservation Areas that Create a Community Who then Ensure Its Sustainability. In K. Leone, S. Komisar, & E. M. Everham III (Eds.), *Making the Sustainable University* (pp. 133–149). Springer Singapore. https://doi.org/10.1007/978-981-33-4477-8_9

Higgins, A., & Klein, S. (2011). The concept of living labs as social infrastructures for innovation. In *Accelerating Global Supply Chains with IT-Innovation* (pp. 123-133). Springer, Berlin, Heidelberg. https://doi.org/10.1007/978-3-642-15669-4_8

Hoffmann, S., Deutsch, L., Klein, J. T., & O'Rourke, M. (2022). Integrate the integrators! A call for establishing academic careers for integration experts. *Humanities and Social Sciences Communications*, *9*(1), 147. https://doi.org/10.1057/s41599-022-01138-z

Hugo, H., Espinoza, F., Morales, I., Ortiz, E., Pérez, S., & Salcedo, G. (2018). Delta Project: Towards a Sustainable Campus. *Sustainability*, *10*(10), 3695. https://doi.org/10.3390/su10103695

König, A. (2013). *Regenerative Sustainable Development of Universities and Cities: The Role of Living Laboratories*. Edward Elgar Publishing Limited. http://ebookcentral.proquest.com/lib/monash/detail.action?docID=1420488

Leal Filho, W., Salvia, A. L., Pretorius, R. W., Brandli, L. L., Manolas, E., Alves, F., Azeiteiro, U., Rogers, J., Shiel, C., & Do Paco, A. (Eds.). (2020). *Universities as Living Labs for Sustainable Development: Supporting the Implementation of the Sustainable Development Goals*. Springer International Publishing. https://doi.org/10.1007/978-3-030-15604-6

Martek, I., Hosseini, M. R., Durdyev, S., Arashpour, M., & Edwards, D. J. (2022). Are university "living labs" able to deliver sustainable outcomes? A case-based appraisal of Deakin University, Australia. *International Journal of Sustainability in Higher Education*, *ahead-of-print*(ahead-of-print). https://doi.org/10.1108/IJSHE-06-2021-0245

Munro, A., Marcus, J., Dolling, K., Robinson, J., & Wahl, J. (2016). Combining forces: Fostering sustainability collaboration between the city of Vancouver and the University of British Columbia. *International Journal of Sustainability in Higher Education*, *17*(6), 812–826. https://doi.org/10.1108/IJSHE-04-2015-0082

Pilon, A., Madden, J., James Tansey, James Tansey, Tansey, J., & Metras, J. (2020). Campus as a Living Lab: Creating a Culture of Research and Learning in Sustainable Development. In E. Sengupta, P. Blessinger, & T. S. Yamin (Eds.), *Teaching and Learning Strategies for Sustainable Development: Innovations in Higher Education Teaching and Learning* (Vol. 19, pp. 213–227). Emerald Publishing Limited. https://doi.org/10.1108/s2055-364120200000019017

Purcell, W. M., Henriksen, H., & Spengler, J. D. (2019). Universities as the engine of transformational sustainability toward delivering the sustainable development goals: "Living labs" for sustainability. *International Journal of Sustainability in Higher Education*, *20*(8), 1343–1357. https://doi.org/10.1108/IJSHE-02-2019-0103

Robinson, J., Berkhout, T., Cayuela, A., & Campbell, A. (2013). Next generation sustainability at The University of British Columbia: The university as societal test-bed for sustainability. In A. König, *Regenerative Sustainable Development of Universities and Cities* (pp. 27–48). Edward Elgar Publishing. https://doi.org/10.4337/9781781003640.00009

Robinson, Z. P., Catney, P., Calver, P., & Peacock, A. (2022). Universities as Living Labs for Climate Praxis. In C. Howarth, M. Lane, & A. Slevin (Eds.), *Addressing the Climate Crisis* (pp. 129–139). Palgrave Macmillan, Cham. https://doi.org/10.1007/978-3-030-79739-3_12

Save, P., Cavka, B. T., & Froese, T. (2021). Evaluation and Lessons Learned from a Campus as a Living Lab Program to Promote Sustainable Practices. *Sustainability*, *13*(4), 1739. https://doi.org/10.3390/su13041739

Save, P. W., & Froese, T. M. (2014, November). UBC Living Lab: Innovation In Accelerating The Adoption Of Sustainable Technologies For Campus Infrastructure. 2nd International Conf. On Urban Sustainability and Resilience, University College London, London. https://doi.org/10.14288/1.0167308

Sharp, D., Anwar, M., Goodwin, S., Raven, R., Bartram, L., & Kamruzzaman, L. (2022). A participatory approach for empowering community engagement in data governance: The Monash Net Zero Precinct. *Data & Policy*, *4*. https://doi.org/10.1017/dap.2021.33

Sharp, D., & Raven, R. (2021). Urban Planning by Experiment at Precinct Scale: Embracing Complexity, Ambiguity, and Multiplicity. *Urban Planning*, *6*(1), Article 1. https://doi.org/10.17645/up.v6i1.3525

Sustainable Smart Campus Initiative. (2020). *Our Campus Our Living Lab*. The Hong Kong University of Science and Technology. https://ebookshelf.ust.hk/flippingbook/G20376/mobile/index.html#p=i

Tercanli, H., & Jongbloed, B. (2022). A Systematic Review of the Literature on Living Labs in Higher Education Institutions: Potentials and Constraints. *Sustainability*, *14*(19), Article 19. https://doi.org/10.3390/su141912234

Torrens, J., & von Wirth, T. (2021). Experimentation or projectification of urban change? A critical appraisal and three steps forward. *Urban Transformations*, 3(1), 8. https://doi.org/10.1186/s42854-021-00025-1

Trencher, G., Terada, T., & Yarime, M. (2015). Student participation in the co-creation of knowledge and social experiments for advancing sustainability: Experiences from the University of Tokyo. *Current Opinion in Environmental Sustainability*, *16*, 56–63. https://doi.org/10.1016/j.cosust.2015.08.001

van den Heuvel, R., Braun, S., de Bruin, M., & Daniëls, R. (2021). A Closer Look at Living Labs and Higher Education using a Scoping Review. *Technology Innovation Management Review*, *11*(9).

van Geenhuizen, M. (2013). From ivory tower to living lab: Accelerating the use of university knowledge. *Environment and Planning C-Government and Policy*, *31*(6), 1115–1132. https://doi.org/10.1068/c1175b

van Wijk, A. (2013). *Welcome to the Green Village*. IOS Press. https://profadvanwijk.com/wp-content/uploads/2013/08/welcome-to-the-green-village-ad-van-wijk-tudelft.pdf

Verhoef, L., & Bossert, M. (2019). *The University Campus as a Living Lab for Sustainability: A Practitioner's Guide and Handbook*. Delft University of Technology, Hochschule für Technik Stuttgart.

Waheed, M. H. (2017). *A Revolution for Post-16 Education – Part 1: A Case for the Living Lab* (p. 12). Environmental Association for Universities & Colleges (EAUC). Available at: https://www.eauc.org.uk/file_uploads/living_labs_project_part_1.pdf

Wiek, A., & Kay, B. (2015). Learning while transforming: Solution-oriented learning for urban sustainability in Phoenix, Arizona. *Current Opinion in Environmental Sustainability*, *16*, 29–36. https://doi.org/10.1016/j.cosust.2015.07.001

Wiek, A., Kay, B., & Forrest, N. (2017). Worth the Trouble?! An Evaluative Scheme for Urban Sustainability Transition Labs (USTLs) and an Application to the USTL in Phoenix, Arizona. In N. Frantzeskaki, V. Castán Broto, L. Coenen, & D. Loorbach (Eds.), *Urban Sustainability Transitions* (1st ed.). Routledge. https://doi.org/10.4324/9781315228389

Yasuoka, J., Cordeiro, G. A., Brittes, J. L. P., Cooper, O. R. E., Bajay, S. V., & Nunes, E. (2022). IoT solution for energy management and efficiency on a Brazilian university campus – a case study. *International Journal of Sustainability in Higher Education*, *ahead-of-print*(ahead-of-print). https://doi.org/10.1108/IJSHE-08-2021-0354

Zen, I. S., D'Souza, C., Ismail, S., & Arsat, M. (2019). University Living Learning Labs: An Integrative and Transformative Approach. *Journal of Sustainability Science and Management*, *14*(4), 17.

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