GW4 living labs: Scope 3 and the road to net zero. A Literature Review

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Abstract

To limit global warming to 1.5°C will only be achieved through a universal transformation of energy and land-use systems. The interdependent nature of these systems means that all sectors of the economy are involved, and so will need to undergo transformation together. How to achieve net zero emissions is still unresolved, and organisations increasingly seek support from external sources of knowledge. Inertia at national and global levels has led to an increase in actions at local levels through place-based initiatives. Consequently there has been an increase in the use of living lab models as places of experimentation and innovation for climate-related research and development. However, there remain questions about what constitutes a living lab and how they work in practice. This literature review briefly examines how living labs are defined, designed and implemented through a combination of conceptual frameworks. It then investigates how universities can serve as facilitators of innovation by co-creating knowledge, initiating action and providing capacity within a living lab model. Finally, a mission-oriented model is offered as a means of communicating living labs in a wider societal context.

1. Background

A 1.5°C increase in global warming is believed to be the tipping point at which climate change would be irreversible. Estimates indicate that with current emissions rates, the carbon budget for 1.5°C warming is likely to be exceeded roughly within the next decade (IPCC, 2021). Carbon emissions have increased by 50% post-Industrialisation (Betts, 2021), with nearly 85% of overall emissions coming from power, industry, mobility, buildings, agriculture, forestry and other land use, and waste (IPCC, 2019). Of these, as much as 90% of an organisation's emissions come from what is known as Scope 3 (Griffin, 2017). More complicated to calculate and more challenging to reduce, Scope 3 emissions include the upstream and downstream indirect emissions in an organisation's value chain that are not covered by Scope 1 and 2[1] emissions and come from all supply-chain emissions associated with the consumption of goods and services, commercial air travel, waste disposal and leased assets.

By December 2021, 70 countries and more than 5,000 companies (Krishnan et al., 2022:1) put net-zero commitments in place. However, around 40% of these companies still need a plan on how they intend to achieve their pledges (IEA, 2021). Poorly prepared and uncoordinated action will present significant challenges and have implications for the success of many initiatives.

To limit global warming to 1.5°C, reaching net zero emissions is crucial, and this can only be achieved through a universal transformation of energy and land-use systems. The wide-spread and interdependent nature of these systems means that all sectors of the economy are involved in some capacity across supply chains and will need to undergo transformation together. While recognising the scale and urgency to achieve this transformation exists, how to achieve it is still unresolved (Baccarne et al., 2015). As a result, organisations increasingly seek support from external sources of knowledge (ibid.), understanding that the traditional siloed approach to working will not be sufficient. It is widely accepted that effective delivery of low-carbon and climate-resilient

[1] Scope 1 emissions originate directly from an organisation's operations (e.g. through petrol or fertiliser use); Scope 2 are emissions associated with the production of the energy an organisation consumes.

development will require new governance arrangements' (Bulkeley et al., 2019; Castán Broto, 2020; Jordan et al., 2018; Kivimaa et al., 2017 (as referenced in Howarth et al. 2022)), involving all stakeholders working together in new ways.

While climate change is a global challenge, its impacts are felt locally, and inertia at national and global levels has led to an increase in actions at a local level through place-based initiatives (Howarth et al., 2022). The use of 'living labs' as places of experimentation and innovation for climate-related solutions is rooted in local and regional action with the potential to create transformative outcomes. Often associated with a quadruple helix of innovation, and more recently through a quintuple helix innovation framework (Baccarne et al., 2015), universities have a role to play in their success. Designed to tackle real-life problems, often linked to the Sustainable Development Goals, structuring living labs around a larger mission-oriented research model has the potential to link projects, allow for interdisciplinary collaboration and act as a communication framework for external stakeholders and funders.

This literature review is organised into three sections. First, it briefly explores the definition and origins of living labs. It then identifies a variety of frameworks that conceptualise how a living lab can be structured and implemented. This is followed by an examination of the role of universities in living lab approaches both in terms of campus and urban living labs. Finally, a mission-oriented model is offered as a means of communicating living labs in a wider societal context.

2. Living Labs origin and definition

The living labs concept is referenced as a methodology, an approach, a framework, a platform, a network (Veeckman et al., 2013), and increasingly as a novel form of governance (Evans et al., 2014). For consistency, this review will refer to living labs as an approach.

With the plethora of interpretations and manifestations, there is, as yet, no definitive definition of a living lab. However, it is widely accepted that what constitutes a living lab, whether a university campus living lab (CLL) or an urban living lab (ULL), is that they all share a shared core set of principles (Figure 1). They focus on solving real-life issues that include the collaboration of all relevant stakeholders in the design, innovation and implementation process in the co-creation of knowledge. A key characteristic of living labs is that end users are involved in the development and research from the beginning. Adopting a multi-method approach, they create an inclusive and collaborative environment which takes into account different interests and backgrounds that involve feedback loops resulting in a process that can be flexible and responsive to the changing needs of stakeholders and communities (Evans & Karvonen, 2014; Evans et al., 2015; Evans et al., 2019;, Veeckman et al., 2013; ENOLL, 2020).

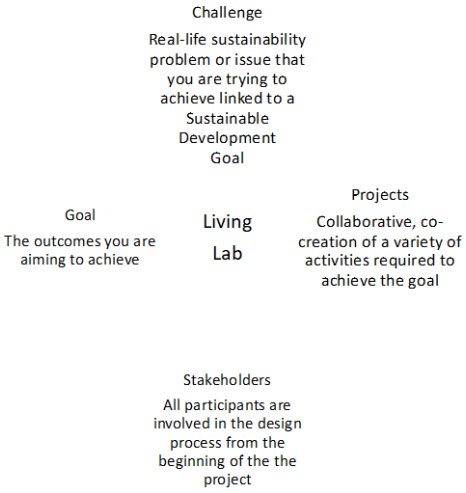

Figure 1: A Living Labs Framework based on characteristics defined by Steen and van Bueren 2017

First used to address technology challenges, living labs have evolved as a popular means of tackling complex sustainability challenges, covering many different domains, such as energy, mobility, health and, more recently, climate change. Therefore, living labs used to tackle sustainability challenges are seen as an approach that supports the achievement of the Sustainable Development Goals (Klautzer et al., 2020).

Living labs began appearing in academic literature in the 1990s (Veeckman et al., 2013; Leminen and Westerlund, 2019), with early living labs originating at the Massachusetts Institute of Technology (MIT) (Ballon and Schuurman, 2015) where they used the university campus as a testbed for sustainability. In Europe, the European Network of Living Labs (ENoLL), created in 2006, can be credited for raising the profile of the living lab concept and is the most influential initiative covering living labs from around the world (Veeckman et al., 2013; Leminen and Westerlund, 2019). ENOLL was established to address the gap between research leadership and the commercial successes of innovation. The large amount of funding awarded to ENOLL projects under the auspice of 'living labs' has resulted in a proliferation of projects termed 'living labs' that are often only loosely related to the concept (Veeckman et al., 2013; Dekker et al., 2020). Steen and van Bueren (2017), in an analysis of literature and 90 experimental projects in Amsterdam, found that only 12 of the 90 can be described as a living lab. The missing component was the inclusion of the user in the development process. "Projects that solely focus on researching, testing, implementing, or demonstrating a pre-developed product in a real-life environment are often referred to as living labs, whereas in fact, they are pilot projects, show-cases, test sites, or demos of existing innovations" (Steen and van Bueren; 2017:14).

3. Living labs - a way of working

Within the accepted definition of a living lab, several frameworks have been developed that conceptualise how living labs operate. These include frameworks which identify the constituent stakeholders, the interaction of stakeholders, the collaborative process and an overview of how the living lab may be implemented and communicated. These frameworks are examples of best practice and models which offer flexibility to match the individual needs of different institutions.

If living labs are considered an approach requiring all stakeholders to respond to the need to find solutions to societal issues, then how they operate and are governed is significant. Governance is

recognised as crucial to the successful transformation of sustainability issues. Whether a large or small-scale project, the inclusion of multiple stakeholders with an array of knowledge and diversity of backgrounds will require new ways of working. (Krishnan et al., 2022; CUN, 2022; Evans, Bulkeley et al., 2017; Bifulco et al., 2017). What form of governance is adopted is outside the scope of this review; however, collaboration, implementation and communication are essential elements (Kalinauskaite et al., 2021).

3.1 Collaboration: Quadruple and Quintuple Helix Model of Innovation

In order to tackle societal challenges, collaboration is an accepted part of the process, but how to collaborate is often overlooked (Kalinauskaite et al., 2021). A collaborative framework that accounts for the complexity of working within socio-ecological contexts is needed to progress governance issues. A crucial element of this process is the involvement of all stakeholders. This is often expressed as operating within a Quadruple Helix of innovation (Figure 2) involving a combination of local authorities, companies, community organisations and universities in a collaborative process to solve real-life problems. The Quadruple Helix model is an extension of the traditional Triple Helix model of university-industry-government-led innovation. Where the Triple Helix model places importance on the knowledge generated by a university for innovation in a knowledge economy, the Quadruple Helix recognises that communicating policy and strategy through a 'media-based democracy' requires acceptance from the public in order to achieve legitimation. Therefore, the sustainability of any knowledge economy relies on the coevolution with the knowledge of society (Carayannis and Campbell, 2009).

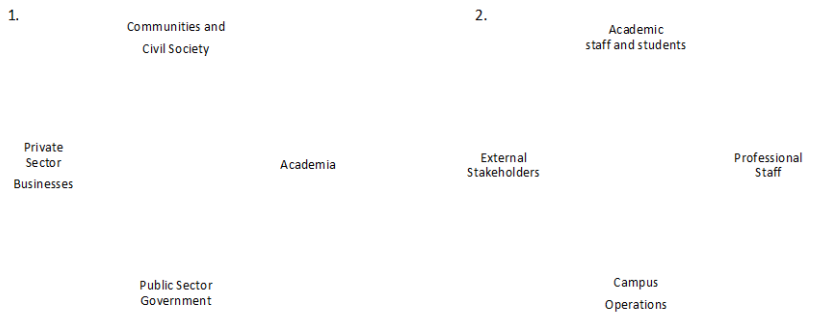

Figure 2. Stakeholder representation for 1. an Urban Living Lab and 2. a Campus Living Lab based on the Quadruple Helix model of Carayannis and Campbell, 2009

As living labs evolved to focus mainly on sustainability issues and complex societal challenges involving climate change and the environment, it is argued that adopting a Quintuple Helix model that incorporates the environment as a critical actor, is more appropriate (Carayannis et al. 2012; Baccarne et al., 2015). The integration of the natural environment as a key actor differentiates it from the other two, where the Quintuple Helix identifies the environment as a driver for knowledge production with the ability to achieve socio-ecological transition and harness green opportunities and foster innovation in a green transition (Carayannis et al., 2012).

3.2 Collaboration: Co-creation

Collaboration in the co-creation or co-production of knowledge and solutions is a core principle of the living lab approach and it is this aspect that sets it apart from other research methods (Evans and Karvonen, 2014). It is also considered the most underdeveloped and identified as one of the main challenges to successful outcomes (Kalinauskaite et al., 2021; Bulkeley et al., 2017). Co-creation of knowledge is seen as a group of people from diverse backgrounds with differing perspectives and different sets of knowledge who come together from the initial stages design and develop solutions to a defined challenge (Mahmoud et al., 2021). University generated knowledge is one type of knowledge, the lived experience is another. These different forms of knowledge have to be integrated in order to have value in complex contexts and this necessitates collaboration (e.g. to implement new knowledge) and co-creation (e.g. to integrate multiple forms of knowledge from the beginning). Adopting this process helps ensure end users are equal contributors rather than subjects of studies (Evans et al., 2019) and are involved in creating social, economic, and environmental solutions that will impact them. It is important to note that navigating collaboration and co-creation will also mean navigating power dynamics.

Based on the analysis of the challenges faced in the set-up of three different types of living labs, Kalinauskaite et al. (2021) developed a framework or collaboration which can be applied at different points of living lab development. Initially, the collaboration initiation phase can be employed to define a vision and a roadmap for the living lab. Once established, information can be put into a missions framework which can be used to structure the project on a macro level. The framework can then be used again to identify the vision and roadmap for the smaller individual projects within the living lab. In a similar vein, Klautzer et al. (2020), in their construction of an Urban Living Lab, develop a framework in which they outline the phases of collaboration into different project stages. In each phase, they developed a set of key questions to guide the collaborative process . Kalinauskaite et al. (2021) and Klautzer et al. (2020) provide examples of how this model offers an opportunity for several universities to collaborate together.

3.3 Implementation

Moving from discussion to action is a challenge to successful living labs, therefore, identifying a method of implementation, or simply ‘how to do living labs’ can be beneficial (Figure 3). In an analysis of theory and practice, Steen and van Bueren (2017) have outlined a method for implementation consisting of eight steps with guidance on conditions and steps required recognising the different pathways that living labs may take to reach their end goal. Within this framework is the understanding that iteration and feedback loops are present and there is not a linear progression from the initiation phase to the solution.

Figure 3: Steps to implementing a living lab based on 'living labs way of working' defined by Steen and van Bueren, 2017

4. Living Labs and Universities

Universities feature prominently in living labs as critical stakeholders in the fight against climate change. They engage with the living lab approach in two ways; as a campus-based living lab (CLL) and as a knowledge hub, host or partner of an urban living lab (ULL). Whether campus or urban-based, universities, as centres of knowledge creation and contributors to urban sustainability, have a critical role in a net-zero transformation. In addition, external stakeholders generally consider universities to hold a neutral position of trust (Gardner et al., 2021). As such, they are seen as an essential partner with local government, business and community organisations as anchor institutions in their locale (CUN, 2022). Therefore, they are in an enviable position and well-placed to play a leading role in driving innovation and development and help facilitate action toward a more equitable society.

Universities undertake a significant and diverse range of activities in response to the climate agenda, but this is said to be "siloed, being led by individual academics or departments with little or no internal coordination or joined-up thinking externally between stakeholders" (CUN, 2022). They are, however, undergoing a transformation and, at a time when they are re-evaluating their purpose and asking themselves what they are good for, their model of operations is shifting from one of a Triple Helix to that of a Quadruple Helix model of operation.

This internal transformation aligns with the core principles of living labs where a "shift towards a whole-systems approach and place-based working highlights the greater opportunity for HEIs to consider themselves as part of the local ecosystems supporting places and communities" (CUN, 2022:5). Having a whole institution or strategic approach is beneficial in aligning initiatives and supporting monitoring and evaluation.

The importance of leadership and governance is a key enabler to the change and transformation in adopting strategic sustainability as an aspirational agenda (Purcell et al., 2019) and the lack of support from management is one of the greatest obstacles to the integration of sustainable development into universities (Leal Filho et al,, 2017). The overriding element of success in sustainability initiatives is that leadership from the top is essential to create a successful top-down, bottom-up approach.

Successful living labs have buy-in across the university by staff, students and partners, they have a specific sustainability strategy and, often have dedicated sustainability teams that lead on the living lab agenda. Organising institutional projects around the SDGs act as a strong convening force connecting the institutional projects with wider goals. The co-creation required to effect delivery against the SDGs was supported by the shared governance space offered by the "living lab" model (Purcell et al., 2019).

Although universities, and for that matter local governments, are increasingly encouraged to follow this Quadruple Helix model, the existing funding and evaluation arrangements continue to follow the classic paradigm of pursuing grants, citations and league table results. In a situation where nearly half of living labs are organised or established by universities (van der Huevel et al., 2021), funding becomes a major issue for financing both campus and urban living labs. In addition, in the aftermath of COVID-19, years of austerity following the financial crisis of 2008, local authority budgets have been severely impacted. Much of the early work of ULL was funded through ENOLL and work at local levels has been reliant on funding from grants. This is rarely discussed in the literature but 'the manner in which innovation is financed, including the length, structure, conditions and characteristics of financiers, affects the outcomes and success of the innovation' (Bellinson et al., 2021:17) and is a challenge that must be addressed in the early stages of collaboration.

4.1 Campus Living Labs (CLL)

Often described as a microcosm of society with housing, transport, food and health services, the university campus is considered one of the most appropriate places for conducting a living lab. As many universities have declared a climate emergency with commitments to cut carbon emissions and set net-zero targets, they are quickly recognising the opportunity of using their campuses as a testbed to conduct applied research to tackle sustainability challenges. In addition, campuses as living labs can provide a pedagogical platform to deliver an experiential learning experience. Shaped around the SDGs and Education for Sustainable Development (ESD) frameworks, the pedagogical benefits of living labs offer innovative approaches for students to gain research skills and develop sustainability competencies, thus transforming the campus into an active learning environment while simultaneously achieving their net-zero targets (Robinson et al., 2022). Likewise, students offer an enormous source of research potential in supporting sustainability issues (Evans et al. 2015). It is important to note, however, that with the growing number of projects calling themselves living labs that simply engaging a student in research on a sustainability issue as part of a practicum, internship or practice track project is not in itself a living lab unless that research forms part of a broader project that engages in an iterative process of experimentation that includes end-users in the design and implementation process (ibid.).

Although a growing number of living labs are publicised on university websites, fewer examples in the literature describe processes, challenges and enablers of campus living labs. In a website search of successful and established university living labs, two features common amongst them is that they are organised centrally, usually through an established sustainability team, and are often linked to Sustainable Development Goals (see references for links to website Massachusetts Institute of Technology (MIT), University of Manchester, University of Bath, University of Edinburgh, University of Leeds University).

4.2 University Examples and Guidance

The University of Manchester's living lab programme (Evans et al., 2015) is organised through the sustainability team. It has adopted a stakeholder-led approach where the university's non-academic environmental consultants identify projects across the university. After this, the living lab team communicates with course leaders to gain insight into the research requirements, coordinate specific programme deadlines, and identify mutually beneficial research opportunities. They adopt a systems approach to enable more significant problems situated in more complex systems to be broken down into smaller complementary projects. Published on their living lab website, students have pre-determined problems or research questions for which they can choose and apply.

Several toolkits have been developed to aid universities in developing smaller-scale living labs; The EAUC Living Lab Model (2018) and The Leeds Living Lab Toolkit (ND) are two examples. The EAUC LL model is derived from multiple academic and non-academic sources, including literature and practical case studies. It is structured around a two-step method. Step one identifies the relationships between stakeholders, and step two is how the LL is implemented based on a set of core principles. The model has both strengths and weaknesses. A particular strength is that it is founded in established and evidenced Living Labs practice. It is also designed to provide flexibility and applicability to a variety of situations and institutions. To ensure this flexibility, it only requires that an HE institution follow three of the seven core principles and allows for the optional choice of the remaining principles. Within the EAUC definition is the 'encouragement' of collaboration and co-implementation, which goes against the generally accepted definition.

However, the remaining 'core' principles, namely the principle of collaboration and co-creation, are considered key principles in the successful implementation of a living lab and are the main components that set a LL apart from other research methods. In addition, the EAUC model "does not necessitate hands-on practical work… and could be solely non-practical; e.g. report, paper, workshops, or other work discussing how the challenge could be addressed" (EAUC, 2018:14), which risks diluting the overall aims of a LL. While this model is adapted to use within HEIs and adopts the core principles of the generally accepted definition and structure of a living lab, several factors can impact the success of a genuine living lab. One is the stakeholder groupings. In particular, the foundational level of relationship where a project only needs to involve two stakeholder groups. When one of these is a student and another a practitioner, it risks resulting in a practicum or dissertation with no co-creation or iterative learning/feedback loop/end-users. Moreover, intra-stakeholder groups do not address the interdisciplinary nature of tackling sustainability challenges and risk resorting to working in siloes. EAUC has developed this guidance to create flexibility and aid the implementation of living labs. While this is agreeable, it does increase the risk of projects masquerading as living labs when they are, in fact, internships or dissertations, increasing the potential risk of failure.

The Leeds Living Lab was developed in 2017 to drive the university's commitment to embedding sustainability into the fabric of the university. Organised through The Sustainability Service, it has established projects in ten schools from five faculties partnering with campus and professional services, external stakeholders, and the city council. The university has developed The Leeds Toolkit, which focuses on the practicalities and processes required to set up and deliver a living lab project within an HE institution. Rather than focus on the theory and principles of living labs, it guides the user through the details of formulating a project, developing a partnership, accessing and generating data, and considering ethics, consent and confidentiality. This, combined with the application of living lab theory and the core principles, create a manageable guide to support the development of a LL project.

4.3 Urban Living Labs (ULL)

As well as campus living labs, the LL framework can facilitate engagement beyond the campus, thus expanding the potential for universities to engage with external stakeholders and support broader sustainability challenges in its locale. Termed urban living labs (ULL), they are local in reach and scale, and as a stakeholder, the university is seen as a place-based institution operating within a civic space and may act as a knowledge hub, host or partner. The Joint Programming Initiative (JPI) Urban Europe introduced the term 'urban living lab' and define it as "a forum for innovation, applied to the development of new products, systems, services, and processes, employing working methods to integrate people into the entire development process as users and co-creators, to explore, examine, experiment, test and evaluate new ideas, scenarios, processes, systems, concepts and creative solutions in complex and real contexts" (JPI Urban Europe, 2013 cross referenced in Voytenko et al., 2015). Created in 2010, JPI act as a hub and a gateway for urban living labs to address global urban challenges with projects in 31 countries.

Cities are, by nature, involved in global consumption, production, and pollution and account for some of the most significant carbon emissions in the world. As cities try to position themselves as leaders in the race to net zero (Voytenko et al., 2015), living labs are seen as a way for cities to become sustainable (Florez Ayala, 2020) and can be used as a bridge between research and society-wide implementation, achieving more impact faster (Steen and van Bueren, 2017).

The understanding of the nature and purpose of ULL is still evolving, however, a distinctive feature of an urban living lab is the focus on civic participation and increased quality of life, rather than the development of a commercial product or service (Baccarne et al., 2014). Much of the recent literature focusses on living labs as a form of collective experimental governance, where stakeholders develop new ways of living to address the challenges of climate change, sustainability and resilience (Bulkeley and Castan Broto, 2013; Voytenko et al., 2015; Bulkeley et al., 2016). Governance is an essential part of urban living labs and is considered a part of the wider shift in sustainability governance (Bulkeley and Castán Broto, 2013

The Amsterdam Institute for Advanced Metropolitan Solutions at Delft University of Technology is one example where a university has adopted a living lab approach where they act as a "networking organization, initiating platforms with local and international partners, both private and public, and above all with citizens and users" (Steen and van Bueren, 2017:4). Their aim is to work with and develop solutions for the city and livings labs are fundamental to their work. They have found that creating a LL requires a large amount of investment in the initial set-up, organisation and on-going management in order to build capacity and sustainability. Through their work and research they have adopted a model of implementation to smooth the process.

5. Communicating Living Labs: Missions

As a Living Lab aims to solve a real-life problem, projects can be designed around a mission-oriented model framed by a specific Sustainable Development Goal. This has the potential to link projects, allow for interdisciplinary collaboration and act as a framework for communication for external stakeholders. Mission-led approaches provide a new lens to innovation, designed to tackle global challenges by taking a more focused approach relevant to society locally and globally. They recognise that complex problems cannot be resolved by working in silos, and they focus more on the problem and less on specific sectors.

Adopting a mission-led organisational structure results in goal-oriented research with more precisely defined objectives. Mission-oriented approaches can be explained as identifying a

challenge (such as an SDG), setting an ambitious goal (mission), identifying main themes around this goal and then using these to create projects, engaging a variety of stakeholders across sectors and disciplines in order to convert these challenges into achievable solutions, they need to be broken down into more manageable component parts which become specific missions. Once a mission is defined, themes, projects and stakeholders are more easily identified. The Greater Manchester Combined Authority (GMCA) in collaboration with The Institute for Innovation and Public Purpose (IIPP) at University College London (UCL) has developed an example of what a missions approach to clean growth might look like (Mazzucato et al., 2019). As this is an example, certain assumptions have been made but they are nonetheless useful to initiate the process and act as a starting point. From this, projects would emerge as part of the collaborative and co-design process (Mazzucato et al. 2019).

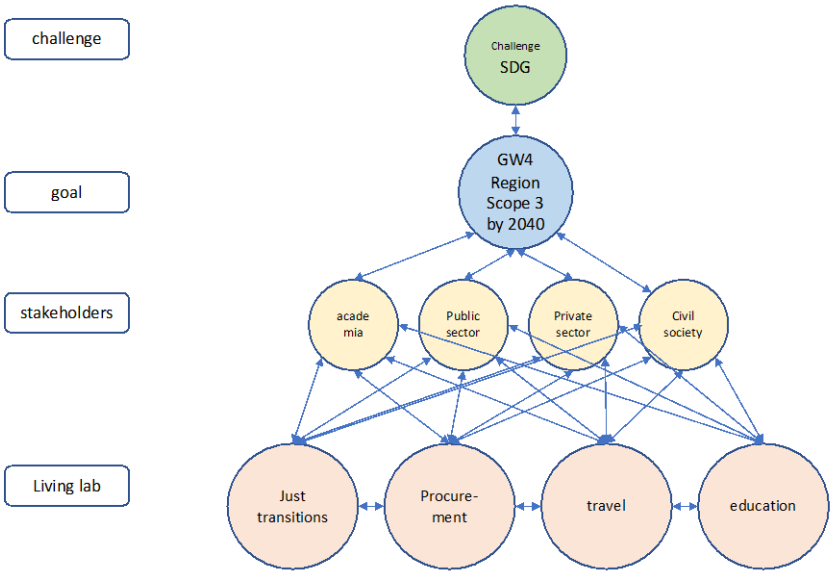

Figure 4. Example of living labs structured around a mission-oriented approach based on the Missions model by Mazzucato, 2018

Although a top-down approach, missions guide the direction and create a pathway, focussing on the problem and not the sector. They rely on a variety of stakeholders and offer the potential for more effective collaboration between actors and across scales, and puts citizen engagement at the heart of the process, creating a sense of shared purpose. In this regard, a mission-led approach is structured much the same way as a living lab and creates the environment for bottom-up experimentation and co-creation of potential solutions. Both can work together to offer an organisational and communications framework. In this way, the challenge is the over-arching goal, and the projects become separate living labs that fit within that context, for example, climate change, biodiversity or education. The projects within the living lab can then be campus-based, local or regional, all contributing to the 'grand challenge' or SDG and providing a way to assess the impact on many levels.

The aim of innovation has long been recognised as a means to stimulate economic growth and theoretically improve well-being. However, perhaps less considered is the fact that innovation also has a direction and focusing on steering that direction can provide more sustainable and just growth (Mazzucato et al., 2018). Having said that, although research and innovation projects have clear objectives, their ability to achieve societal impact may be restricted if not linked to their ability to address global challenges. On the other hand, the SDGs are too broad, and therefore action is slow. Together, mission-led research and the SDGs complement each other and can offer a new paradigm that integrates human development while maintaining Earth's systems (Mazzucato et al., 2018). By framing missions around the SDGs, Mazzucato demonstrates how research, innovation and

investments can be directed in ways that solve complex problems and create new development pathways that contribute to growth and job creation.

The OECD describes mission oriented research as having the potential to become one of the most significant vehicles for change in the coming decades, and provides guidance, case studies and a toolkit for implementation on mission-oriented policies for net zero (OECD, 2021, 2022). This concept is enthusiastically adopted by the European Union, featuring prominently in the Horizon Europe research and innovation funding programme for 2021-27. At the same time, The UKRI Strategy: Transforming tomorrow together 2022-27 (2022a) commits to enhancing 'place-based benefits of actions and investments, contributing to the wider levelling up agenda' and 'involving a broader range of people in the design and delivery of research' while the UKRI Accelerating Net Zero Delivery report (2022b) demonstrates the economic case for local climate action, offering an opportunity to align with national priorities and demonstrate progress towards global goals

The increase in and siloed approach to research activity around the climate agenda, although positive, makes it difficult to coordinate and track initiatives and monitor impact (CUN, 2022). With the overall increase in funding efforts that are being encouraged by UKRI focussed around reaching net zero, living lab projects designed as part of a mission-led approach within the SDG framework can help coordinate and scale up projects and track the impact that these projects are having. Structured in this way, they create a holistic approach to practice which can change the conditions that create poverty, inequality and environmental destruction. They contribute to local agendas resulting in a connected city and region and globally supporting broader development goals. A university's role as an anchor institution allows for a 'more strategic collaboration between the HEI sector and between HEIs and stakeholders could capitalise in the opportunity to level across' (CUN, 2022).

6. Conclusion

If a 1.5^{o}C world is to be achieved, urgent action is needed to achieve net zero emissions. While climate change is a global challenge, its impacts are felt locally, and there is an increase in locally led initiatives. These initiatives increasingly take the form of living labs, sometimes structured around UN Sustainable Development Goals, demanding collaboration from across sectors of society in the design and research process. Universities have a part to play in the process and their role as anchor institutions allows for a more strategic collaboration between stakeholders to forge a path towards a net zero transition. In order for living labs to be successful and achieve long-term sustainability, two key elements need careful consideration: the inclusion of all stakeholders from inception; and, a clear and funded governance structure that will allow living labs to progress beyond the initial collaboration phase.

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