



LOW CARBON LIVING
CRC


An Australian Government Initiative



Collaborative research in the real world

Review of Living Laboratories



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Foreword

This report is an output from a scoping study of living laboratories (RP3005: CRC Living Laboratory Framework), which examined what living labs are, their benefits and what they need to be successful. It is primarily intended to inform partners in current and prospective CRCLCL projects, so that they might consider these aspects of living laboratories when designing and implementing their projects.

The living laboratories model represents a major new trend that can bring together all the key stakeholders in innovative processes so that the outcome is more integrated, more democratic and more effective for all concerned. Projects of the CRL for Low Carbon Living will be more effective in their efforts to reduce carbon if they heed the lessons to be learned from this model.

The CRC for Low Carbon Living (CRCLCL) is a national research and innovation hub that seeks to enable a globally competitive low carbon built environment sector. With a focus on collaborative innovation, we bring together property, planning, engineering and policy organisations with leading Australian researchers. CRCLCL develops new social, technological and policy tools for facilitating the development of low carbon products and services to reduce greenhouse gas emissions in the built environment. The CRCLCL is supported by the Cooperative Research Centres (CRC) program, an Australian Government initiative.

For more information go to www.lowcarbonliving.com.au

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Disclaimer

The opinions in this report are those of the authors and do not necessarily represent the views of CRC for Low Carbon Living Ltd, partners, affiliates, individual board members or reference group members. Any remaining errors or omissions are the responsibility of the authors.

Peer Review Statement

This report has been reviewed by the project partners .

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Executive summary

Living laboratories are a new way to structure research that emerged in Europe in the past decade. They involve key stakeholders – particularly researchers, industry, government and innovation end-users – in collaborative research in real-world settings to ensure that innovations are practical and acceptable in the specific circumstances of those intended to use them. Though living labs can work for a wide range of subjects, they are well suited to the challenge of reducing carbon, and thus are a highly appropriate structure for CRCLCL projects.

Their advantages are many. They:

- manage stakeholder cooperation
- lead to the pooling of complementary resources
- research the whole innovation process from conception to effective application in the real world
- encourage the sharing of innovations
- give end-users and communities more power in change processes and thereby deepen democracy
- make innovation more visible to those who need to help it along.

In setting up and operating living laboratories there are a number of things to attend to:

- bringing together stakeholders and creating appropriate governance and management structures
- ensuring that parties to the process – who can have very different interests, resources and ways of operating – work well together
- successfully engaging end-users in the process
- arranging finance
- carrying out research
- managing intellectual property concerns while promoting open access to innovation
- disseminating information about living lab outputs and encouraging widespread up-take.

Living lab participants can be helped in this process by the CRCLCL, by the European Network of Living Laboratories (increasingly a global network), and by networking with each other.

This review includes descriptions of a number of living laboratories, particularly European ones, and of the European Network of Living Laboratories (ENoLL). Information was drawn from a tour of European living labs and ENoLL, and from academic and web-based literature on the subject.

Introduction

Living laboratories provide a way to structure research and innovation so that those involved work together more cooperatively, and the end result constitutes a better response to the preferences and circumstances of innovation end-users and others affected, and to environmental imperatives. Researchers, industry, government and often end-users collaborate on the research and development, testing it out in real world settings.

As such, it is an ideal arrangement for the CRC for Low Carbon Living, which is seeking practical solutions to the enormous and pressing challenge of reducing carbon emissions in Australia and beyond. Research can be a slow process and, even when a product or service is developed, the task of producing that product or making that service available en masse, and then promoting and selling it, extends that process even further. The urgent threat of climate change does not afford us the luxury of taking time to reach and apply effective solutions. As in a war effort, it's necessary for all parties to work together expeditiously, in this case to develop ways of lowering carbon that are demonstrated to be acceptable and feasible in the real lives of those who need to adopt them or are affected by them.

These ways to reduce carbon can include not only products and services, but also planning processes, regulations, incentives and disincentives, information provision, behaviour change programs, community projects and a range of other measures.

Living laboratories – as the term is most commonly understood – emerged in Europe in the past decade. Also referred to as living labs, their number has grown rapidly, and they are now spreading around the world. The European Network of Living Laboratories (ENoLL) currently has around 320 member labs, and interestingly about a sixth of these are located outside Europe.

Living labs vary greatly, but they commonly bring together the researchers, the government bodies (often local councils) and the industries involved in their projects, through an agreement or shared management structure. Thus from the outset resources and expertise can be pooled, and all the parties to the arrangement can put on the table what they want and need from the joint effort.

Labs also engage end-users in new ways, such as in the 'co-creation' of the innovation, in helping to design and conduct research, or in the management of the lab alongside other stakeholders, as well as in more conventional roles as providers of information and feedback. The rationale for this is that:

- End-users are the experts on the products and services that will best meet their needs and preferences.
- End-users represent an under-tapped source of ideas and creativity.
- Their involvement in shaping changes in their own lives extends the democratic space.

Living labs concern themselves with a wide variety of subjects and, perhaps surprisingly, only a small proportion of existing ones focus predominantly on sustainability. Most concentrate on information and communications technology, solely, or jointly with other subjects. Some focus on building developments, or on arts or entertainment projects, while quite a number address how the needs of the disabled or older adults can be met in community settings. But they are naturally suited to the task of lowering carbon and the broader challenge of sustainability because, with the involvement of multiple stakeholders, labs are more likely to consider multiple needs and perspectives, including the need for sustainability.

Examples of living laboratories

Living labs can be best understood when we look at specific labs, and the following are some examples:

Australia's Future Logistics Living Lab¹

This lab, the only Australian member of ENoLL, brings together more than 30 participants, including logistics companies, IT providers, universities (including the University of NSW) and other research institutions to develop new logistics solutions for Australia. It is also supported by the NSW Department of Trade and Investment, Regional Infrastructure and Services. Two of its priorities are to 'realise seamless, paperless, and standardised flow of information along the supply chain' and to 'monitor and reduce carbon footprint across multiple logistics service providers'.

Groups of participants come together to work on specific projects. For example, one project, IdeaWall, 'transforms any whiteboard or wall into an electronic whiteboard, just by using an iPhone and a projector. The technology enables participants to collaborate from different locations and brainstorm ideas. IdeaWall captures content from the meeting and helps participants build ideas from a brainstorm'. Another project, Container Tracking, seeks to 'to understand, analyse and reduce movements of empty containers between ports and container parks.

Nina Tunk, Research Practice Manager at SAP Research, sees the lab as helping to optimise logistics performance 'along the whole supply chain, really breaking down the siloes in today's logistics industry [and] creating transparency between different modes of transportation, different logistics service providers and countries'. As Bonnie Ryan, Industry Manager at GSI Australia, puts it, 'if information flows smoothly then so will the goods'. John Ansley, President of Supply Chain Solutions and CIO at Linfox, expects the lab to be 'a place where people go if they're looking for fresh ideas and partners who they want to work with'.

City Lab Coventry²

City Lab Coventry in the UK is a joint effort of Coventry University and the City of Coventry, and is managed by the university.³ It focuses on hydrogen and electric vehicles, low impact buildings, integrated transport and logistics, digital media, sustainable agriculture and food, and solutions for an ageing community.

Coventry was the centre of British car manufacturing and, with the decline of that industry, efforts are being made to generate new forms of sustainable industry and employment, such as in electric and hydrogen vehicle development. On another front City Lab Coventry is working to reduce the carbon footprint and general environmental impact of buildings, focusing on areas that include the creation of building materials from waste, sustainable brownfield development, and better energy monitoring.

Between them, Coventry University and Coventry City Council own 90% of the land within Coventry City Centre, and this offers 'a real-life experimentation environment where users and producers can co-create and test innovations'.⁴ A high priority is assisting the many small to medium enterprises (SMEs) in the city. City Labs Coventry offers industry direct access to citizens and user groups, and has also built strong links with large firms and industry associations.

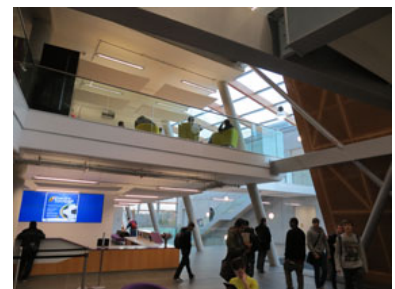


Figure 1 Inside Low impact building, City Lab Coventry.



Figure 2 Outside Low impact building, City Lab Coventry.

Another facility the lab offers is 'a serious games studio / app lab, staffed by 30 developers providing specialist support in the creation of 3D immersive simulations and serious games, from prototype development through to full commercialisation'.⁵

City Lab Coventry's Director of Strategic Relationships, Joanne Dobson, sees the main benefits of the lab as twofold. Firstly, it brings together all the key stakeholders, including end-users, in a collaborative and integrated effort to develop sustainable industries and improve wellbeing. Secondly, the lab's profile means it has support at senior levels within the City, the University and other stakeholder organisations, and these senior decision-makers have the power to make progress on its projects easier, for example, through fast-tracked planning approvals.

Fondaterra And The Urban Living Lab (Versailles Saint-Quentin-En-Yvelines)⁶

Fondaterra is a Foundation of the University of Versailles Saint-Quentin-en-Yvelines, south-west of Paris, and along with the Urban Living Lab, which it hosts and initiated about a year ago, it has engaged in a range of projects in the areas of energy, buildings, transport, urban planning, smart cities, climate change and economic growth, through action research, training and information dissemination. It has three industry partners – two energy companies and a construction firm.⁷

So far Fondaterra have been instrumental in getting over 80 projects going. One, called Valterris, involves helping restaurants and university, school and corporate caterers to source local, sustainably grown food – working with farmers' associations and cooperatives – and also to recycle the food waste sustainably. Through the Urban Living Lab students and the university work together in a number of areas, including producing renewable energy on campus, and introducing a fleet of electric vehicles for student car sharing.

Fondaterra also undertakes energy audits for universities and has developed tools for campuses to measure energy efficiency. It is committed to providing open access to the knowledge it has a hand in generating, and to this end it organises 'challenges' where substantial cash prizes are awarded to the winning innovators, in return for which there is open access to the knowledge and technologies they have created, rather than these being withheld from the public domain through patents.

The Flemish Living Lab Platform⁸

Based in Mechelen, Belgium, the Flemish Living Lab Platform focuses on the spreading of digital technology for information, communication and entertainment in Flanders, the Dutch-speaking region of Belgium.

It is funded 50% by the Flemish Government and 50% by telecommunications companies, and is a consortium of large companies, a research institute and other organisations (including non-profits). It has a user panel of 600 people, now being expanded to 2000, who are engaged in trials of products and services.

FLLP focuses on three domains: Smart Grids, Smart Media and Smart Cities. In the Smart Cities domain a computer network called Nuvonet provides citizens with information about their cities, and there are moves to make this network more neighbourhood-based and user-driven, with an NGO being launched to run workshops for users.

Although sustainability is not prominent in the lab's stated objectives, it advances low carbon living through its promotion of smart grids, smart metering, ICT enabled transport information, and local connectedness.

According to its Director, Mark De Colvenaer, its projects need to create value for people, or they won't be interested in participating. Moreover, end-user or community participation is not always easy to achieve, he notes, with the differing cultures of the stakeholders often throwing up challenges. For example, industry and other stakeholders can have very different attitudes when it comes to the speed of doing things and the time devoted to discussion. Here he advocates a two-stage process: an initial open but brief period of discussion (what he calls a 'playground', which involves 'leaving the stakes outside'), followed by more task-focused planning where the stakes of the different parties are more to the fore, and there is more attention to efficient use of time and resources in the collaborative process.⁹

Urban Transition Öresund¹⁰

Eastern Denmark (Copenhagen and surrounding areas) and south-western Sweden (Malmö and its hinterland) are known as the Öresund region after the strait running between them, but it is only a 20-30 minute trip from one city to the other by road or rail, and these parts of Denmark and Sweden are cooperating to establish the Öresund region as a European and global leader in sustainable development.

Urban Transition Öresund is a key element in this effort.¹¹ It has ten partners: five local governments and five universities. Five of the partners are in Denmark and five in Sweden. Regional authorities and clean-tech businesses are also part of the arrangement. UTO doesn't call itself a living lab, but it certainly fits the definition. It is focusing on residential and commercial (rather than industrial) development, and the initial phase of its work consists of mapping existing examples of collaboration, particularly across the border, noting how regulations and practices differ in the two national jurisdictions, and what each can learn from the other. UTO is concentrating on developments in six precincts, including new developments in the Western Harbour brownfield site in Malmö, and predominantly retrofits in the Copenhagen suburb of Skt. Kjild's.

These developments are proceeding independently of Urban Transition Öresund, but its involvement adds value to the process. There is an emphasis on exploring new techniques for dialogue, data gathering, planning, the visualisation of planned changes, consideration of multiple factors and the testing of outcomes, with workshops being run for participants on topics like:

- mobile/smart phone video and streaming technologies in urban planning
- urban games, and game development in urban planning
- soft values – handling the social in urban transitions
- negotiating and visualising long term outcomes of investments.

In precincts where there is already an established community, such as Skt Kjild's, residents are very involved in the process, in that case with local committees, representation of these committees and local organisations on the project Steering Committee, and participation in the development of neighbourhood plans by residents, businesses, societies and institutions. There is also a focus on the project promoting health, mobility and social connection.

Urban Transition Öresund's first Gaming Workshop in December 2012, with professional games developers working with project partners to develop games that can help participants imagine and plan changes to the urban environment.



Figure 3 Urban Transition Öresund's first Gaming Workshop in December 2012,



Figure 4 Urban Transition Öresund's first Gaming Workshop

Low2no, Finland¹²

This innovative alliance of partners (it also doesn't call itself a living laboratory, though it is very much like one) is based in Helsinki and has Finnish and international partners. Its title expresses its aim of moving from low-carbon to no-carbon living, and it seeks 'to balance economy, ecology and society through strategic investments and interventions in the built environment'. Partners include Sitra (the Finnish Government's Innovation Fund), architectural and engineering firms and the City of Helsinki.

One of its projects is a highly innovative, mixed-use development featuring multi-storey timber construction with renewable energy generation and a range of other solutions to radically reduce carbon emissions. It also conducts and publishes studies on topics of public interest, such as a study of street food, which examines how to move towards food entrepreneurship that enhances well-being, diversity, quality and sustainability.

A history of networking

William Mitchell from MIT coined the term 'living laboratory' in the 1990s. It has two related but distinct meanings. It can refer to a physical facility in which research subjects actually live and carry out the normal activities of daily life, using new technologies and being observed doing so by researchers in order to assess the technology's effectiveness for the user. Examples of such facilities include PlaceLab at MIT¹³ and ExperienceLab at Philips.¹⁴ More commonly, the term refers to living labs that emerged in Europe in the early 2000s, labs that, rather than being a physical place, are more an organisational arrangement for engaging multiple stakeholders in the research process, although carrying out that research in real world settings is a key aspect as well. The two uses of the term are not contradictory, though in the first one end-users of products are merely observed rather than being engaged in the co-creation of the innovation. It is the second, more common use of the term that this scoping study has focused on.^{15, 16, 17, 18}

From the time of their inception in Europe, living labs have been communicating and cooperating with each other, and this was formalised in 2006 with the creation of the European Network of Living Laboratories, or ENoLL, with 19 inaugural member labs.¹⁹ Cooperation among living labs has been well-supported by the European Commission, for which this is one of a number of ways to strengthen the integration of countries within the European Union, and to foster collaboration between government, industry and other institutions in pursuit of sustainable economic and social development. Many living lab projects have been commissioned or funded by the Commission.

Since the establishment of ENoLL its membership has grown rapidly with successive 'waves' of new member labs.²⁰ Now it has members on all continents, and there is discussion within the network of a more global structure to reflect this global membership, a matter that will be addressed at the First Worldwide Conference on Open Living Labs, in Amsterdam, 11-13 November 2013.²¹

ENoLL supports its 320-odd member labs in a variety of ways:

- It disseminates information through its website, online newsletter and other channels.
- It facilitates communication between labs.
- It promotes member labs to the wider world, for example, through their own page on its website, and, as approved members, labs have ENoLL's imprimatur.
- It arranges events, such as an annual summer school, and as of this year an international conference.
- It has working groups in which member labs can participate.
- It brokers collaboration and consortium building.
- It is a market place in which living labs can offer their services.
- It provides information on funding and can help to arrange funding.

Some of what it offers is available to non-members, such as the summer school, the conference, and access to its website. As it becomes a more global network, the challenge will be to ensure that the above services are just as available to labs outside Europe as they are to the European ones, but labs that are members of ENoLL will be much better placed to influence this process than labs that aren't members.

The potential is there; the only Australian member of ENoLL is already an associated partner in a project receiving European funding.²²

Benefits of living laboratories

As a research and development arrangement, living laboratories have a wide range of benefits, which should be understood by those considering starting one up or supporting it in some way. Key benefits are as follows:

Living Labs Allow Stakeholders To Work Together Cooperatively From The Outset, Taking All Stakeholders' Needs And Preferences Into Account.

The process of taking an innovation from conception to effective application by end-users can involve many different parties – public or private researchers, designers, planners, manufacturers, financiers, promoters, wholesalers, retailers, regulators, community members and groups in some way concerned with the innovation, and of course end-users.

All of the government, private enterprise and community organisations involved have their own particular values, goals, interests and constraints, their resources and knowledge bases, their timelines and ways of operating. If these different organisations interact only minimally and at arm's length, then there will most likely be a lack of common purpose, serious information blockages and inefficiencies in the innovation process. Resources may be channelled into creating multiple uncoordinated plans of action that may later need to be scrapped or radically changed, with the possibility of legal disputes and all the added costs and delays that this entails.

But if there is a process whereby, from the start, the different parties can collaborate in a more or less structured way, then the needs and preferences of each party can be clearer from the outset, differences can be reconciled and a broad common vision developed early in the piece. It will not necessarily be easy, but it should be possible. Living labs can help to break down 'traditional hierarchical and competitive approaches to innovation' and to frame it in a more experimental and collaborative manner.²³

Living Labs Pool Resources, Knowledge, Expertise And Creativity, Including Those Of End-Users.

Living labs allow a project to draw on the knowledge, capacities and resources of parties that may not have otherwise even been involved in the innovation process – such as end-users, researchers or local council sustainability planners – or it allows that project to draw on them more fully if relationships between parties would have otherwise been more arms-length. Thus it expands the sum of the material and informational assets available to the lab. And given that the assets stakeholders possess can be very different from each other, assets provided by particular stakeholders would not necessarily have been available from others. For example, only end-users can provide information about what they want and need and, equally importantly, what is too complex, too impractical, too expensive and too unattractive, and what is unacceptable to the end-user's peer group. End-users are experts on their own needs, preferences and circumstances, so involving them constitutes smart marketing, as it helps to 'alleviate the risk involved when launching a new product, technology or service'.²⁴

Labs can enable small to medium enterprises to access assets that may normally only be afforded by larger businesses, for example, research outputs and panels of end-users. And with the global reach of some participants, labs can 'help companies rapidly commercialise and upscale an innovation to a global market'.²⁵ Moreover, living labs 'contribute to cost efficiency by spreading research costs among businesses, research, and public organisations'.²⁶

As one commentary has expressed it,

'urban laboratories present an attractive mode of governance that promises to transform cities into sites of knowledge production that will make them simultaneously more economically viable, socially robust and environmentally friendly'

²⁷ The world is becoming too complex to *not* collaborate, with 'growing evidence the autonomous activities of single organizations cannot produce the cross-disciplinary systemic innovations that would sufficiently address the increasingly sophisticated needs of the market'²⁸ not to mention non-market considerations.

Living Labs Research The Whole Innovation Process From Conception To Effective Usage.

In more conventional research arrangements, formal academic research may end with the testing of a product in a laboratory environment, and the steps that need to follow this are simply characterised as publicity, production or marketing, and are not researched with the same seriousness, if at all. But a carbon-reducing product, service or other mechanism does not start to reduce one gram of carbon until it is being operated or applied effectively by its end-users, and so it is necessary to research with equal seriousness how potential users can learn about the innovation, whether they like it and consider it useful, whether it suits their financial and practical circumstances, and whether they are able to use it successfully, if necessary with the help of further information or training. Because living labs tend to engage end-users, they inevitably treat these latter stages of an innovation's development with greater seriousness.²⁹ But a key part of this is involving end-users in the early stages of the whole process when decisions are being made that bear on eventual consumer take-up.

Living Labs Share Innovation And Its Benefits Around.

Within living laboratories intellectual property can be protected through patents in the same way that it is in other research and innovation processes, and it often is. But open access to living lab outputs is encouraged, because it allows the fruits of the innovation process to be made widely available, which is especially important if the process is aimed at the public good. If there is public or non-profit funding involved, this is easier to achieve. An alternative to patenting is to offer prizes for the development of particular innovations, a strategy adopted by Fondaterra, a foundation in Versailles that supports a living lab there.³⁰

Living Labs Help To Deepen Democracy.

It is widely recognised that, valuable as representative democracy is, it has serious limitations, and the current level of public disenchantment with our political system reflects this. End-user and broader community engagement in the innovation process through living laboratories is one important way in which people can play a part in shaping the world around them. But this is not simply a case of people 'having their say' or 'getting what they want'. As has already been noted, living labs draw on people's creativity, on their ideas, knowledge and values, and they encourage dialogue and provide means for people to learn more about the subject at hand in order to make more informed decisions. But the issues involved can go well beyond the merely technical, and the process leading up to decision-making may not always be smooth, but may include some 'creative unsettlement and mobilization'.³¹

Living Labs Give Innovation Processes Higher Visibility And Profile.

It is often said that we live in an age of information overload. If we want to get messages across we need to compete with a multitude of other messages in modern society. Structuring something as a living lab can help in this process.

"Living labs draws together the countless actions by many people in a range of stakeholder groups and publicly declares, 'These are part of the same undertaking. There's a large and important process occurring here. This is a new way of doing things and it's worth taking notice.'"

It draws together the countless actions by many people in a range of stakeholder groups and publicly declares, 'These are part of the same undertaking. There's a large and important process occurring here. This is a new way of doing things and it's worth taking notice.' In other words, it gives all these activities conceptual and organisational coherence, shape and definition, and thus makes the whole project more visible and distinctive. This affects how the project is treated. According to Joanne Dobson from City Lab Coventry, that lab's profile means it has support at senior levels within the City, the University and other stakeholder organisations, and these senior decision-makers do all they can to ensure progress on its projects, for example, through fast-tracked planning approvals.³² The visibility of a living lab also means that it is more likely to be noticed by mass media, business, other levels of government, and the general community. Innovation isn't just about having good ideas; it's also about getting those ideas into the consciousness of the people who need to know about them and act on that knowledge.

Setting up living laboratories

To realise the benefits of living labs there are many things to be borne in mind. What follows suggests some key steps to take and factors to consider in setting up and operating a lab, but advice can also be sought from those within the CRCLCL who are supporting living lab development, and from outside bodies such as ENoLL. Networking with other CRCLCL living labs would be useful too.

Bringing Together The Stakeholders

Which businesses, organisations and groups will – or should – play key roles in the process of research and innovation you are engaging in? The ones you decide have key roles are obvious candidates for membership of and a role in your living lab. Some may take on particular management, financial or other responsibilities in the lab, others may be regularly involved in decision-making, while yet others may simply be consulted about key decisions or about their own contribution, needs and preferences. In the context of the CRCLCL, signed-up participants in your living lab do not have to be CRCLCL partners.

Creating An Organisation, With Structures For Governance And Day-To-Day Management

A board or committee of management having responsibility for the overall governance of the lab can be set up, preferably with major stakeholders represented on it. This may comprise representatives of bodies engaged in research (universities or the CSIRO), industries with major roles in the lab's undertakings, and any local governments or departments or agencies of state or federal governments that are significantly involved. As well, if it is feasible, it can have representation of end-users and/or communities affected by the lab's work. Not all living labs have such a structure. Many exist as an organisational unit with a larger body – most typically, a university or a local government – though even in these cases they may have a governing or advisory body with representation from other organisations.

In addition, there will need to be a structure for the day-to-day management of the living lab, with allocated management roles and responsibilities, and lines of authority, in order to manage the work of paid or voluntary staff or others engaged in the lab's work on behalf of participant organisations.

In some cases, as is discussed below in the section on the financing of labs, responsibility for specific projects that are the subject of lab activity is taken by a single entity, normally one or more of the business partners, and the lab just adds value to this process, for example, through research or engagement with end-users. In such cases the governance and management structures of the living lab, on the one hand, and specific (normally commercial) projects on the other, are quite separate, although they need to harmonise of course.

Living labs tend to have quite flat, participatory management structures, in line with the values of those involved and the prevailing philosophy of living labs, which is about broad participation – including in decision-making – and the benefits that this can bring to the process.

Living labs, like any organisation, need sound accountability processes and, as is discussed later, the lab's research can contribute to this, in that it assesses the effectiveness of the work undertaken, its outputs and outcomes in relation to the time and resources that partners have invested in it.

Ensuring That Partners Work Together Effectively

The stakeholders in a living lab project – researchers, governments, industries, end-users and others – can have quite different goals, interests, constraints, knowledge bases, ways of operating and timelines. If they are to work together they need to reconcile these differences to the extent that, for each of them, they can participate effectively, and the costs of participation don't outweigh the benefits to themselves or to the goals they are pursuing. So stakeholders should be encouraged to be open about matters that are, or may be, of concern to them, and other stakeholders encouraged to take note of this. Then participants can jointly address how these concerns might be addressed. For example, industries that have high operating costs, and need to get on with projects in order to realise a return on their investments as soon as possible, may favour much faster discussion and decision-making processes than end-users may prefer. As has already been mentioned, Flemish Living Lab Platform's response to this is to have a two stage discussion process – an exploratory, but still relatively short initial period of discussion (a 'playground'), and then much more focused discussions in specific areas. According to participants in Urban Transition Öresund, a key to working successfully with businesses is finding one person within the business who is committed to the process, and just working with and through that person as much as possible.³³ This may apply to other kinds of stakeholders as well.

"Endusers can be co-creators of the innovation, participants in the design and execution of research, and even participants in the governance or management of the lab"

Successfully Engaging End-Users In The Process

The engagement of end-users (and to a lesser extent community members) is a distinctive feature of living labs. As has been noted, their involvement can go well beyond that of providers of feedback and information; they can be co-creators of the innovation, participants in the design and execution of research, and even participants in the governance or management of the lab. It's more likely that end-users and community members will participate as individuals rather than as members of collective bodies in the way that participants from business, government or research institutions are. They are likely to be much less well resourced, have less formalised knowledge of a subject, and be less used to working within complex organisations and inter-organisational structures. On the other hand, they may be affected much more by the decisions the lab takes and have a lot of informal knowledge of the subject.

It is important that these imbalances be redressed as much as possible:

- that end-users have access to technical and other background information in language they can understand, and access to workshops or other training if necessary
- that the lab's work, processes and structures be fully explained
- that all verbal and written communications be as comprehensible as possible
- that visualisation technologies be used to convey planned or possible futures, especially if these are outside the experience of end-users
- that funds be available to ensure that end-users can participate effectively
- that, if possible, they have their share of positions of authority within the lab.

The imbalances that need to be corrected are sometimes referred to in the literature as information or power 'asymmetries'. If there are large institutions and businesses involved, these asymmetries will generally remain to some extent, because it's unlikely that end-users will ever have the capacity that larger players have to co-ordinate other stakeholders or manage all the complexities involved,³⁴ but it is certainly worth trying to reduce them. Ways to engage and inform end-users and community members should be explored. For example, there would be great benefit in incorporating into living laboratories 'deliberative democracy' approaches that are a special area of expertise for CRCLCL colleagues Janette Hartz-Karp and Margaret Gollagher from Curtin University.³⁵

In the tour of European labs undertaken as part of this scoping study, various ways to do this were observed. For example, in Belgium's Ghent Living Lab, local residents (that is, end-users of information services) attended a series of workshops to learn how to maintain an information website.³⁶ The Flemish Living Lab Platform was planning similar workshops for the same purpose. In Urban Transition Öresund, as has been noted, Skt Kjild's residents were very involved in the retrofitting of their locality, with participation, individually and through local groups and committees, in the development of neighbourhood plans, and representation on the project Steering Committee.

The Manchester Living Lab (officially the Manchester Digital Development Agency) engages community members who are also computer 'geeks' in projects for the public good. It has created 'Madlab,' in which these community members meet weekly to discuss their individual projects – which can concern local to global level issues – as well as sharing them online. Manchester City Council has committed itself to making as much of its data as possible available to support this decentralised research.³⁷ Malmö Living Labs works hard to identify projects for specific sections of Malmö's population (for example, African immigrants) that address important needs and can be carried out with the active involvement of the participants themselves. Its projects occur within one of three 'nodes': the 'Neighbourhood' (tackling complex urban challenges); the 'Stage' (undertaking cultural production); and the 'Factory' (accessing tools, technologies, knowledge and skills to experiment with and prototype ideas, products and services).³⁸

The nature of end-user participation in the development of innovation is very much dependent on the subject of the innovations. If it concerns the development of sustainable transport in a city, then residents might participate in early discussions focusing on their needs, preferences, circumstances and ideas. If it is a smart meter or other kind of information technology, then end-users may not be able to participate meaningfully in the development of the technology's internal workings, but they can try out prototypes of the device and say what does and doesn't work for them, and what might work better.

However, involving prospective residents in the design of a new housing (or mixed use) development can be difficult, particularly in Australia, given that most such developments here are not built for a specific client – such a housing cooperative or association, a more common occurrence in Europe – but rather are designed and then sold off the plan or upon completion to individual buyers. End-users can be engaged in the design process if it is an individual dwelling or business premises (but this is merely standard practice), if it is a retrofit for existing owners or occupiers (as in Skt Kjild's), if the client is a housing cooperative or association, or if public housing authorities allow prospective tenants to engage in such a process, as has occurred, for example, in Victoria.³⁹ It is not sufficient to simply consult the surrounding community, because they can have quite different interests. For example, they may oppose higher density developments, whereas potential buyers may be happy with such density, especially if it allows them to live closer to jobs, shops and public transport, or gives them the option of a smaller or less expensive home.

On the other hand there is much scope to work with owners and occupiers of housing and other premises once they have taken possession or moved in, because operating a sustainable building effectively is often not a simple process, and innovations need to be tested out to see if they really work as intended in the lives of real people. Moreover, to work as intended may require that information, advice and even training are available. So working with owners and occupiers of a new building can consist of two things: developers learning how functional and sustainable the building actually is when occupied (which will inform the design of future developments), and owners and occupiers learning – through advice, workshops, and online or printed material – how to operate buildings optimally, with regard to temperature control, ventilation, shading, lighting, planting, reading smart meters, maintenance, the time of day to run appliances, water use and so on. Moreover, if new residents are brought together to learn how to operate their homes effectively, this can be the beginnings of a community-building process that can have all sorts of social and environmental benefits, such as encouraging residents to shop, socialise and even work more locally. As the CRCLCL's focus is on emission reductions in the built environment, getting user engagement right in living labs that focus on building developments is an important matter indeed.

Financing The Living Lab And Its Work

Finance for the core operations and projects of living labs can come from a variety of sources, for example, any or all of the stakeholders, commercial lenders, government grant programs, or a combination of these. The CRCLCL can finance the research work of CRCLCL living labs but other costs will generally need to be met from elsewhere.

In cases where living lab projects are commercial ventures they are often undertaken and financed by commercial stakeholders, and the research and perhaps other elements simply add value to the process. The living lab can be a 'platform' that supports and adds value to any number of projects which are funded by particular stakeholders taking financial responsibility for them. The lab still has to fund its core operations, and usually one or more of its key stakeholders does this, most commonly local councils or universities (and of course this happens automatically if the lab is in fact a unit of one of these bodies).

Non-commercial labs can seek funding from a range of sources, for example, local, state or federal governments, philanthropic trusts, fundraising activities, or web-based crowdfunding schemes like Kickstarter, Indiegogo or, in Australia, Pozible and StartSomeGood.

Researching The Living Lab's Innovations

The kind of research that occurs in living labs constitutes one of their major distinguishing features. It is research that takes place in real-world settings, or as close to real-world as possible. This has been referred to as *in vivo* research, as opposed to *in vitro*.⁴⁰ And as part of being *in vivo* – in the lived world – the research needs to cover the entire innovation process, right through to its successful use in the life of the end-user. Along the way it should address:

- whether it can feasibly be produced and distributed, so that it can be available to end-users
- whether end-users like it, and whether it is practical and affordable for them (or if it is to be subsidised, whether such subsidisation is affordable)
- whether end-users are able to use it effectively (and in this case whether doing so actually reduces carbon)
- whether operating it effectively requires particular information, advice or training.

The research methodology can be any kind that is appropriate to this setting: qualitative or quantitative, case studies or surveys of specific populations. It has been noted that living laboratory studies 'tend to be descriptive and specific in their applicability due to their inability to manipulate variables and isolate cause-and-effect mechanisms',⁴¹ but this is true of much research outside controlled environments, and as more subjects are researched results can become more reliable for a broader population.

CRCLCL living lab research will be built around the development and trialling of one or more products, services or other mechanisms that can help to reduce carbon emissions. On occasions some end-users may be involved in designing or carrying out the research alongside others, and if so they may need some backgrounding in research principles.

The research has value on two levels. In the context of the living lab as a commercial or social enterprise that is generating innovations, it gives substance to the accountability process, demonstrating to stakeholders – who have invested their time and resources and may be significantly affected by the lab’s outputs – what is working and what isn’t, what has to be changed and in what ways. In a broader societal context, it adds to the stock of knowledge about what reduces carbon emissions most effectively in particular contexts.

It is in this broader societal context that the dissemination of information about the lab’s outputs is so important. The living lab will have an immediate catchment of end-users who can be reached without great effort, because they are already connected in some way to the lab or to early users of its outputs. But if those outputs have value for the wider world – and certainly they do if they reduce carbon effectively – then more concerted efforts need to be made to spread the word about the innovations. Of course it will be important to publish results in refereed publications and to speak about them to academic audiences. But given that a key feature of living labs is that they are more closely engaged in the wider world, with greater involvement of multiple stakeholders, including end-users, it is critically important that there are means of disseminating results that are appropriate to this real-world engagement, that get the message across using language, styles and media that have impact and reach, clarity and persuasiveness for the people who need to hear the message. So it may be via facebook, twitter, apps, blogs or websites, via videos or public talks, via TV, radio, magazines or newspapers, or through communications with government, industry or civil society.

Managing Intellectual Property Issues

‘Open innovation’ is a key feature of living laboratories. As part of being situated in society and to some extent ‘owned’ and supported by society, or at least parts of it, it is appropriate that the innovations that flow from living labs should be available to society as well. Many, perhaps most living labs are very oriented to generating innovations that have a strong public benefit, even if they have to operate commercially at the same time. In the case of reducing carbon emissions, there is a substantial public benefit to be had from open access to technologies and methods that achieve this. On the other hand, it is argued that unless commercial firms get some finance benefit from their investments, there is no point in their involvement (unless it’s a charitable undertaking).

Patents and copyright are not the only way to protect intellectual property. It is often said that the best way to protect one’s financial stake in an innovation is to develop and sell it before anyone else does. Along similar lines, Mark De Colvenaer from the Flemish Living Labs Platform has sought to assure small and medium firms contemplating involvement in the Lab Platform’s projects – many of whom are concerned that the larger telecommunications companies involved may steal their IP – that the telcos want the SMEs to develop and supply their complementary products, because these telcos don’t want to do this themselves.⁴² So more open access to intellectual property doesn’t have to mean losing out on your investment.

As mentioned earlier in the description of Fondaterra in Versailles, another option is to offer reasonably substantial prizes to innovators, on the condition that there is open access to the innovation that wins the prize. This is particularly practical for small to medium enterprises that may not have the resources to properly guard their innovations anyway.

None of this is to argue that there isn't or shouldn't be intellectual property protection in living laboratories. Stakeholders should declare any existing intellectual property related to the research. Then ways of dealing with IP created in the lab's projects need to be discussed and decided upon. According to Dave Carter, the Director of the Manchester Digital Development Agency (a living lab in that city) and someone involved at senior levels within ENoLL, issues of IP can usually be easily managed within labs. Once pre-existing IP is identified, he sees three options for IP developed in the project: a shared IP agreement; a creative commons licence (allowing use by others under certain conditions); or open access to the innovations developed.⁴³

Those concerned about IP issues should pursue the matter through the CRCLCL administration or seek advice from their own legal advisors.

Spreading The Solutions Across Australia

As was noted earlier, the impact of innovation developed in a living lab can be greatly magnified if a concerted effort is made to disseminate information about it as widely as possible, and some ways of spreading the word were mentioned earlier. But providing information, though important, is not sufficient. Research into what causes people to change their behaviour has come up to a range of conclusions, of which the following are key ones:

- Ways need to be found to change people's actions, not just their beliefs, because very many people have accurate knowledge and beliefs but these are not translated into actions.
- If people can be persuaded that the desired change is already happening, this will show that it is both feasible and normal.
- The actions of role models and peers are very influential, as they shape norms of behaviour.
- Changes have to be feasible in the context of a person's specific life circumstances, as different circumstances often require different solutions.
- Solutions should be demonstrated, and broken down into do-able steps.
- People need incentives to change, and, in the case of change toward lower carbon living, focusing on its wellbeing benefits, which are well-supported by evidence, is one important way to provide such an incentive.

Thus, community engagement programs that draw on the data, the stories and the products of living labs, and are guided by the findings just described, can help to magnify the carbon-reducing work of CRCLCL living laboratories. In fact, such community engagement efforts can be the focus of some of these living labs' work.

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