Urban living labs for sustainability and low carbon cities in Europe: Towards a research agenda

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Exploring Urban Living Labs for Sustainability and Low Carbon Cities in Europe

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Abstract: The urban population in Europe is expected to be 80% in 2020. Urban living labs (ULLs) are emerging as a form of collective urban governance and experimentation to address the sustainability challenges and opportunities created by urbanisation. They have different goals, they are initiated by various actors, and they form different types of partnerships. There is no uniform ULL definition. However, many projects studying and testing living lab methodologies are focusing on urban sustainability and low carbon challenges, as demonstrated by the current projects funded by the Joint Programming Initiative (JPI) Urban Europe. At the same time, there is no clear understanding of what the ultimate role of ULLs is in urban governance, and whether they represent a completely new phenomenon that is replacing other forms of participation, collaboration, experimentation, learning and governing in cities. There is a need to clarify what makes the ULL approach attractive and novel. The aim of this article is to examine how the ULL concept is being operationalised in contemporary urban governance for sustainability and low carbon cities. This is undertaken through the analysis of academic literature complemented with five snapshot case studies of major ongoing ULL projects in Europe. Five key ULL characteristics are identified: geographical embeddedness, experimentation and learning, participation and user involvement, leadership and ownership, and evaluation and refinement. Four topics are found relevant when comparing ULLs: ways to operationalise the ULL approach, the type of ULL partnership and the role of research institutions, the types of challenges addressed by different ULLs, and the role of sustainability, environment and low carbon agenda in ULLs.

Keywords: Urban living labs; sustainability transitions; low carbon cities; knowledge co-creation; experiments; learning

Highlights:

- European cities face many sustainability challenges and opportunities.
- Urban living labs (ULLs) are emerging as a form of collective urban governance.
- There is a need to clarify what makes the ULL approach attractive and novel.
- We explore how the ULL concept is operationalised in contemporary urban governance for sustainability and low carbon cities.
- We start developing a database of ULLs for sustainability and low carbon transitions in Europe.

1. Introduction and background

Today, over 50% of the world population lives in cities, and the number of urban residents grows by 60 million each year (United Nations, 2014). The urban population is projected to increase by another 2.5 billion in 2050 and constitute 66% of the global population (United Nations, 2014). While 90% of the future urban growth is predicted to take place in Asia and Africa, in Europe around 75% of the population already lives in urban areas and this number is expected to increase to 80% by 2020 (Anderson and Galatsidas 2014; EC 2014). As cities become more and more economically productive, urbanisation trends are likely to lead to even further deterioration of natural resources, aggravation of climate change and other environmental problems, as well as pose social challenges such as poverty, inequality and segregation.

In response to these challenges, different forms of urban governance are being developed and tested in European cities. Urban living labs (ULLs) constitute a form of experimental governance, whereby urban stakeholders develop and test new technologies and ways of living to address the challenges of climate change and urban sustainability (Bulkeley and Castán Broto 2013). For cities trying to position themselves as innovation leaders in the race to decarbonise and become sustainable, ULLs are both high profile statements of intent and increasingly essential vehicles to secure funding for sustainable urban development. For funding bodies and governments, they offer a way to encourage cities to adopt innovative solutions.

Living labs for sustainability and low carbon cities emerging in Europe have different goals and ways of working, they are initiated by various actors, and they form different types of partnerships. There is clearly no uniform definition of living labs (Schliwa 2013; Ståhlbröst 2008; Hillgren 2013). Some scholars and organisations define them as partnerships between sectors (often between public, private and people) (Börjeson 2008; Rösch and Kaltschmitt 1999; EC 2015; ENoLL 2015) where universities play a key role (Evans and Karvonen 2010), while others look at living labs more in the light of pilot and demonstration projects, which function as supportive tools for private actors and industry helping them commercialise their services, products and technology (Kommonen and Botero 2013; Hellström Reimer *et al.* 2012). Living labs can be considered both as *arena* (i.e. geographically or institutionally bounded spaces), and as an *approach* for intentional collaborative experimentation of researchers, citizens, companies and local governments (Schliwa 2013).

The Joint Programming Initiative (JPI) Urban Europe, which is the main funding agency for living lab related projects in European cities, introduced the term "urban living lab" (ULL) and defines 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). ULLs can also be viewed as spaces designed for interactions between a context and a research process to test, develop and/or apply social practices and/or technology to a building or infrastructure.

Debate concerning whether a living lab approach can help govern urban sustainability and low carbon transitions has been heightened in academic and professional circles by their recent and rapid proliferation. In Europe, many projects studying, exploring, testing and applying living lab methodologies have emerged in response to sustainability challenges and opportunities that cities are facing (ENoLL 2015; JPI Urban Europe 2015). This is directly linked to the availability of the targeted JPI Urban Europe funding for researchers, practitioners, innovators, municipalities and other stakeholders to develop European urban areas. JPI Urban Europe has had two calls for project proposals, in which the need to explore the role of ULLs has been specified. In total, 20 projects have been granted funding in 2013 and 2014, out of which six either study or employ ULL methodology. One of these projects is the Governance of Urban Sustainability Transitions:

Advancing the role of living labs (GUST)[1], which aims to examine, inform and advance the governance of sustainability transitions in cities through ULL. This article forms part of the GUST project and its research to investigate the design and development of ULLs in Europe.

At the same time, while many ULL related projects are emerging, there is no clear understanding of the ultimate role ULLs can or should play in urban governance, whether they represent a completely new phenomenon or if they are replacing other forms of participation, collaboration, experimentation, learning and governance in cities. There is an obvious need to clarify what makes the ULL approach attractive and novel, including why funding agencies are investing in exploring its usefulness and why local collaborations are trying to operationalise the ULL concept in real-life settings, and the potential impacts of ULLs and their ability to catalyse urban sustainability and low carbon cities.

Therefore the aim of this article is to contribute to knowledge on how ULLs are being operationalised in contemporary urban governance for sustainability and low carbon cities. The article seeks to respond to the following research questions (RQs):

1) How is the ULL concept positioned in the theory on urban governance and articulated and applied by ongoing research projects in Europe?
2) How are ULL in selected projects assembled and embedded, what are their goals, and in which ways is their design similar and varied across urban contexts?

The RQs are examined through the analysis of academic literature on the forms of urban governance complemented with five snapshot case studies of major ongoing ULL projects in Europe that aim to contribute to sustainability and low carbon transitions in cities. Apart from responding to the RQs and contributing to the knowledge on current ULL developments in Europe, this article also begins the development of a database of ULL in Europe that have a potential to contribute to low carbon transitions in cities. While some projects have attempted to map existing and emerging living labs in various European countries before (c.f. Silver and Marvin 2014), and the European Network of Living Labs (ENoLL) includes 370 living labs in its database (ENoLL 2015), the knowledge is scattered on which and how many of these mapped examples are ULLs, and focusing on sustainability and low carbon cities.

[1] http://www.urbanlivinglabs.net/

2. Methods

2.1 General approach and methods for data collection and analysis

The basis of this article is a review of academic publications, policy and grey literature, and current projects on urban governance and living labs in Europe. It is supported by a snapshot case study analysis of five ongoing research projects, which are designed to explore or apply ULL methodology with the purpose to contribute to sustainability and low carbon cities. Criteria to select case studies are outlined in sub-section 2.2.

This work applies a qualitative methodology to data collection and analysis, which is preferred when the phenomenon is new and when the investigator seeks to answer "why" and "how" questions (Yin 2014). It is also used when a researcher has little control over events and when the focus is on a contemporary phenomenon (projects exploring or testing living lab methodology) within real-life context (cities and urban areas). The qualitative approach is used in this work as it aims to explore the conditions under which specific outcomes occur (e.g. ULLs emerge), the mechanisms through which they occur (e.g. mechanisms to study or establish ULLs), "rather than uncovering the frequency with which those conditions and their outcomes arise" (George and Bennett 2005).

The article is based on a triangulation approach (Denzin 1978) to the collection and analysis of data. First, a literature analysis consolidated the schools of thought on urban governance, and positioned the living labs approach within these studies. Second, the snapshot cases were selected (see sub-section 2.2), a literature analysis of project material was performed, and the data was structured and rationalised. In-case analysis focused on the project aim, definitions of ULL, and how the ULL approach is theoretically and practically operationalised in each case study. Third, a cross-case comparison was performed to respond to the research questions. The cross-case comparison identified similarities and differences of ULL projects in terms of how they use the ULL concept, their partnerships, topics and areas for ULLs, and relevance to sustainability and low carbon agendas.

2.2 Snapshot case studies and limitations

The case studies include five out of 20 European projects, which are funded by the JPI Urban Europe within its two targeted calls in 2012 and 2013 (Table 1). These projects are selected as they:

- use the terminology "living labs", "urban living labs" and/or "city labs" to study, explore, test or apply living labs methodology either to an existing urban infrastructure or by establishing new ULLs; and
- study or create ULLs with an explicit objective to tackle urban sustainability and decarbonisation challenges.

While selecting five top-down initiated projects supported by a single funding agency may entail a number of limitations (e.g. leaving out grass-root initiatives and bottom-up ULLs, which are not driven by a research institution, and locking in examples to a limited number of countries, which are eligible for JPI funding), we argue that the sampling approach is representative of the current situation in Europe. First, the evidence exists that the majority of living labs rely on external funding in the establishment phase (Silver and Marvin, 2014), and JPI Urban Europe is a key funding institution for the projects exploring ULL methodology in Europe. Second, it has been shown that most ULL for sustainability are initiated by research institutions or universities (Evans and Karvonen 2014), which helps address the bias that the studied projects are all led by academia. The findings thus contribute to current knowledge and understanding of the role of living labs in tackling sustainability challenges and catalysing low carbon cities in Europe.

Table 1. ULL projects used as case studies

#	Project name	Acronym	Partners and countries
1	Action Oriented Research on Planning, Regulation and Investment Dilemmas in a Living Lab Experience	APRILab	Aalto University (Finland), Aalborg University (Denmark), Amsterdam University (The Netherlands), Yildiz Technical University (Turkey)
2	Co-creating Attractive and Sustainable Urban Areas and Lifestyles	CASUAL	Nordic Centre for Spatial Development (NORDREGIO) (Sweden), Austrian Institute for Spatial Planning (Austria), Technical University Delft (The Netherlands), an exhibition and a meeting space Färgfabriken (Sweden)
3	Green/Blue Infrastructure for Sustainable, Attractive Cities	Green/Blue Cities	Luleå University of Technology (Sweden), the University of Innsbruck (Austria), Technical University Delft (The Netherlands)
4	Social Uplifting and Modernization of Suburban Areas with the Urban Living Lab Approach	SubUrbanLab	IVL Swedish Environmental Research institute (Sweden), Botkyrka municipality (Sweden), VTT Technical Research Centre (Finland), City of Riihimäki (Finland)
5	Towards New Forms of Urban Governance and City Development: Learning from URBan Experiments with Living Labs and City Labs	URB@EXP	Maastricht University (The Netherlands), The City of Maastricht (The Netherlands), Lund University (Sweden), Malmö University (Sweden), The City of Malmö (Sweden), a foresight and design studio Pantopicon (Belgium), the City of Antwerp (Belgium), Graz University (Austria), the City of Graz (Austria), the City of Leoben (Austria)

3. Theory: Urban living labs through the lens of governance

Urban living labs constitute a mode of governance that promises to deliver valuable outcomes by bringing relevant stakeholders together to address challenges and produce solutions in real world settings. The emergence of ULL can be situated within a broader diversification of governance over the last 25 years. In response to increasingly restricted municipal funding, local governments have turned to partnership-based modes of governance that bring public bodies, universities, government, and industry together to address specific sectorial and spatial challenges (Percy 2008). In this sense, ULLs are continuous with urban development approaches from the 1990s onwards that have been characterised by partnerships and area-based initiatives that focus on interventions in particular places.

But while clearly fitting in to a longer lineage of urban governance, ULLs are also suggestive of something new. Their potential to catalyse rapid technical and economic transformation has increasingly positioned them as key drivers for low carbon and sustainability transitions. For cities trying to establish themselves as innovation leaders in the field of sustainability, ULLs are high profile statements of intent and effective vehicles with which to secure national and European funding. The design and functioning of ULL is critical as successful experiments are increasingly important to urban and regional economic trajectories (Gibbs and Krueger 2007). For funding bodies and governments, specifying ULL projects offers a way to encourage risk-averse authorities into adopting innovative urban solutions without having to engage in the more politically fraught processes of structural or policy reform. But while ULLs are proliferating, their origins, impacts, and implications for urban governance remain largely unexamined.

A primary driver for the adoption of ULLs in relation to sustainability and low carbon cities has been the challenges associated with climate change, which has prompted local policy-makers to cultivate 'new techniques of governance' for urban sustainability (Hodson and Marvin 2007). The proliferation of ULLs epitomises the turn to experimental approaches to governing climate adaptation (Bulkeley and Castán Broto 2013). Climate experiments represent the practical dimension of adaptation – they are what happens in practice when policy-makers, researchers, businesses and communities are charged with finding new paths (Evans 2011). ULLs represent a specific form of experimentation, whereby processes of innovation and learning are formalised, and it is this that sets urban laboratories apart from more general policy experiments or innovation niches (Bulkeley and Castán Broto 2013). The appeal of experimentation is that testing out new technologies and policies under real world conditions in highly visible ways can prompt radical social and technical transformation (Evans and Karvonen 2010).

A second driver for the adoption of ULLs is that they offer a vehicle through which to enact and test smart city initiatives, providing platforms for co-production and innovation aimed at transforming urban governance (Baccarne et al. 2014). The ULL approach is based on the much vaunted quadruple helix model of partnership whereby government, industry, the public and academia work together to generate innovative solutions. Juujärvi and Pesso (2013) define ULLs as physical regions 'in which different stakeholders form public-private-people partnerships of public agencies, firms, universities, and users collaborate to create, prototype, validate, and test new technologies, services, products, and systems in real-life contexts". They suggest that ULL are characterised by a focus on 'urban' or 'civic' innovation, which strengthens the public elements of urban innovation.

A defining characteristic of ULLs is that they territorialise urban innovation at a manageable scale, but within this there is considerable variation. Within the rapid uptake of ULLs it is possible to find examples of both techno-centric and socially driven forms of innovation. One initial ULL typology (Silver and Marvin 2014) differentiates between ULL with various logics (i.e. post-carbon living, techno-oriented, knowledge producing and supporting economic growth), settings (i.e. different constellations of actors involved in designing and running ULL), focus (i.e. new technology, climate, building retrofit, food production, urban landscape, sustainability, low carbon economy),

activities (i.e. research, testing, training and education, R&D), and timeline (i.e. long term, temporary, uncertain). While many ULLs "offer a potential to achieve a low carbon economy by developing innovative energy solutions, stimulating greater cross-disciplinary research in universities and enhancing the ties between institutions that create knowledge and those that use it" (Evans and Karvonen 2013), not all of them are designed with a low carbon rationale in mind but can also be oriented at promoting economic growth or enhancing social cohesion.

In term of impacts and implications for urban governance, research highlights the risk that overly techno-centric ULL fail to produce innovation or learning and can be easily co-opted by dominant economic interests. In their study of the Clean Urban Transport Europe Programme that trialled green transport solutions in major European cities, Hodson and Marvin (2009) argue that these projects are little more than demonstrations of existing technologies and services, and that they did not engage local populations or context. Work conducted on the Oxford Road Corridor in Manchester, UK, has highlighted similar challenges concerning how to achieve social inclusion in ULL projects, and the de-politicisation of urban governance that corporate-led partnerships and scientific modes of governance threaten (Evans 2011; Evans and Karvonen 2014).

The ability of ULLs to contribute to urban sustainability and low carbon transitions thus depends on how they are designed and executed in practice. An emerging body of work seeks to understand ULLs as Urban Transition Labs, drawing conceptually on the field of transition management to suggest how they can co-create pathways to wider urban change (Nevens *et al.* 2012). Drawing on the insights of transition management, this work suggests that the degree to which ULL are able to stimulate broader changes beyond their institutional and spatial boundaries is directly related to the exact composition and structure of ULL partnerships, which determines which actors are included and the collective rules of experimentation (Schliwa, McCormick, and Evans forthcoming).

In terms of urban governance, ULLs are neither entirely new nor completely contiguous with past approaches. While they fit into the longer term institutionalisation of innovation under the neoliberal logic of urban competitiveness, they also promise a more inclusive and open process of experimentation that is capable of addressing pressing urban policy agendas surrounding the climate change and smart governance (Bulkeley, Edwards, and Fuller 2014). As a result ULLs are being inserted into and overlaid onto existing urban governance structures, practices and networks. The remainder of this paper sheds light on this process by examining the design, establishment and goals of cutting-edge ULL initiatives within their broader urban context.

4. Results: Examples and experiences of urban living labs

4.1 European projects on urban living labs

This article examines five projects funded by JPI Urban Europe, which covers 22 examples of ULLs (Table 1 and Table 2). The projects are presented in more detail under the following sub-sections. The projects display the diversity of areas and themes under the ULL concept. However, all the projects provide insights into key examples and experiences of designing and developing ULLs in European cities.

Table 2. Basic information about European projects on urban living labs

#	Project acronym	Project aim	ULL relevance
1	APRILab	To explore political dilemmas that constrain innovation in cities	The living lab approach is used as a methodology to study existing urban structures and processes
2	CASUAL	To explore how to promote sustainable living and consumption in cities via stakeholder engagement	The usefulness of a living lab approach is explored by creating, managing and studying two ULLs
3	Green/Blue Cities	To develop knowledge and tools to use green and blue infrastructure in New Kiruna City to handle storm water	The ULL approach is used to bring citizens, practitioners, decision makers and researchers together, and jointly develop innovative solutions for managing storm water
4	SubUrbanLab	To examine how suburbs can be modernised and socially uplifted to make them more attractive, sustainable and economically viable	The ULL approach is used to integrate people into the development, planning and implementation of actions to modernise the suburbs
5	URB@EXP	To develop guidelines on the types of problems for which ULLs are most suited and how they can be best integrated into formal local government organisations	The usefulness of a living lab approach is explored by reviewing experiences of urban labs, and through action research in urban labs in five European cities

4.1.1 APRILab

The project "Action Oriented Research on Planning, Regulation and Investment Dilemmas in a Living Lab Experience" (APRILab) is funded by the First JPI Urban Europe Pilot Call (2012) (JPI Urban Europe 2015). It is led by the University of Amsterdam (the Netherlands), and includes partners from Aalto University (Finland), Aalborg University (Denmark), and Yildiz Technical University (Turkey) (AISSR 2014). It also has Amsterdam Municipality Project Management Office as a professional partner (Wallin 2014).

The project aims to research three fundamental political dilemmas that constrain effective innovation and include: 1) intervention (between control of spatial processes and accommodation of emergent urban change); 2) regulation (between instrumentalism and generic normative guidance of self-regulation); and 3) investment (between supply and demand driven investment strategies) (AISSR 2014). The APRILab project defines a living lab as "any kind of user-centred research and development in an open-innovation ecosystem that has a territorial context (e.g. city, agglomeration, region) and that integrates concurrent research and innovation processes within a public-private-people partnership" (Wallin 2014). In addition, co-creation, exploration, experimentation and evaluation are highlighted as the main principles of a living lab approach.

The APRILab project has developed guidelines on how to apply the living lab approach to explore and analyse the participatory structures, stakeholders, communication and learning processes in a number of selected ULLs, which constitute existing urban areas (for cases see sub-section 4.2) (Wallin 2014). According to APRILab, a living lab should be user-centred (i.e. the users/participants have an active role in the planning); part of an urban ecosystem/city; supportive of open innovativeness (i.e. knowledge transfer is enabled within and beyond institutional boundaries); and connected with the real urban environment.

4.1.2 CASUAL

The project "Co-creating Attractive and Sustainable Urban Areas and Lifestyles" (CASUAL) is funded by the First JPI Urban Europe Pilot Call (2012) (JPI Urban Europe 2015). It is led by the Nordic Centre for Spatial Development (Sweden), and includes partners from the Austrian Institute for Spatial Planning (Austria), Technical University Delft (The Netherlands), and an exhibition and a meeting space Färgfabriken (Sweden) (Nordregio 2013).

The project aims to explore how to promote sustainable living and consumption patterns by engaging people, as citizens and consumers, along with other urban development actors in the governance of urban areas (Nordregio 2013). Among other tasks it seeks to study whether the ULL approach can be used to pursue innovation benefits (Schmitt *et al.* 2014). When operationalising the living lab concept in its work, the CASUAL project lists the following ULL features: 1) co-creation, exploration, experimentation and evaluation; 2) public-private-people partnerships; 3) self-organisation; and 4) focus on urbanism with a shift towards bridging the gap between R&D and commercialisation of products (Schmitt *et al.* 2014). In addition, three central points that characterise an ULL are specified: situated experimentation by users, participatory approach in real-life scenarios, and inclusion of "major" institutions (Schmitt *et al.* 2014).

The CASUAL project explores the usefulness of a living lab approach by assessing its scope, feasibility and robustness when it concerns the mobilisation and integration of various stakeholders (Nordregio 2013). It does so by studying one ULL, and creating and managing two ULL at the neighbourhood level in Vienna and Stockholm (for cases see sub-section 4.2) (Nordregio 2013).

4.1.3 Green/Blue Cities

The project "Green/Blue Infrastructure for Sustainable, Attractive Cities" (Green/Blue Cities) is funded by the First JPI Urban Europe Pilot Call (2012) (JPI Urban Europe 2015). It is led by Luleå University of Technology (Sweden), and includes partners from the University of Innsbruck (Austria) and Technical University Delft (The Netherlands) (JPI Urban Europe 2014a). The project is conducted in close cooperation with Kiruna Municipality, Sweden (Goldkuhl 2014).

The project aims to develop knowledge and tools to seize the opportunities to manage urban storm water in a way that facilitates robust, synergistic and multi-functional green infrastructure to address current and future climate and other changes in dynamic urban areas (JPI Urban Europe 2014a). In practical terms the purpose of the project is to use green and blue infrastructure (e.g. trees and ponds) in New Kiruna City to handle storm water instead of using traditional piped networks (Goldkuhl 2014).

The Green/Blue Cities project finds the ULL approach valuable as it allows for knowledge co-creation by scientists from different countries with various backgrounds and other city stakeholders (JPI Urban Europe 2014a), and applies it to achieve its goals and tasks. It also highlights several key features of an ULL. First, the ULL methodology implies a collaborative and systematic approach to developing innovative solutions by bringing together citizens, practitioners, decision makers, and researchers (JPI Urban Europe 2014a). Second, the users are involved in the project from its early stages. Third, ULL are situated where the process in focus is taking place. Fourth, the ULL approach allows for transdisciplinary learning and knowledge integration. Fifth, the research completed in an ULL is open for unexpected discoveries and learning that originates from the users (Goldkuhl 2014).

The project conducts its work in an international ULL in Kiruna, Sweden, and two national ULL (so called "city-hubs") – one in Austria and one in the Netherlands. The main purpose of using the ULL approach by this project is to bring together citizens, practitioners, decision makers, and researchers, to jointly develop innovative solutions for managing storm water (JPI Urban Europe 2014a).

4.1.4 SubUrbanLab

The project "Social Uplifting and Modernization of Suburban Areas with an Urban Living Lab Approach" (SubUrbanLab) is funded by the First JPI Urban Europe Pilot Call (2012) (JPI Urban Europe 2015). It is led by the VTT Technical Research Centre (Finland), and includes partners from IVL Swedish Environmental Research Institute (Sweden), Botkyrka Municipality (Sweden), and the Riihimäki Municipality (Finland) (SubUrbanLab 2015).

The project aims to examine how suburbs in less valued areas can be modernised and socially uplifted together with the residents and other stakeholders in order to turn these suburbs into more attractive, sustainable and economically viable urban areas (JPI Urban Europe 2014b). It applies the ULL methodology to set up six ULL: three in Finland and three in Sweden (see sub-section 4.2). SubUrbanLab defines ULL as "development environments that integrate residents and other stakeholders to develop and test new solutions in their daily life in the real urban context" (Friedrich, Karlsson, and Federley 2013). The project leaders highlight the importance of citizen participation with the help of co-design methods in the whole process from identifying stakeholder needs to implementing and evaluating the solutions (Friedrich, Karlsson, and Federley 2013).

The SubUrbanLab project has developed guidelines on how ULL can be designed in practice. The guidelines focus on five core elements to be considered when setting up an ULL: context, goals and vision, people and motivation, management and decision making, and an interaction process and methods (Friedrich, Karlsson, and Federley 2013). Context wise the ULL are considered to be regional forums (i.e. their distinctive feature is that they exist in a certain geographical area). When deciding upon ULL goals and visions as well as when evaluating and updating these ambitions, the participation of stakeholders is crucial. It is important to select which stakeholders should definitely be involved as in most cases it is impossible to engage everyone; the rule of a thumb is that the broader the issue, the smaller the participating group. Except for stakeholder participation, the management of an ULL is vital for it to function, and thus an ULL should have a clear owner or leader. Methods for interaction with stakeholders should involve both face-to-face and virtual techniques, and should be adjusted to various stakeholder groups (e.g. children).

4.1.5 URB@EXP

The project "Towards New Forms of Urban Governance and City Development: Learning from URBan Experiments with Living Labs and City Labs" (URB@EXP) is funded by the Second JPI Urban Europe Pilot Call (2012) (JPI Urban Europe 2015). It is led by Maastricht University (The Netherlands), and includes partners from the Maastricht Municipality (The Netherlands), Lund University (Sweden), Malmö University (Sweden), the Malmö Municipality (Sweden), a foresight and design studio Pantopicon (Belgium), the Antwerp Municipality (Belgium), Graz University

(Austria), the Graz Municipality (Austria), and the Leoben Municipality (Austria) (JPI Urban Europe 2014c).

The project aims to develop guidelines concerning types of problems for which ULL are most suited and how they can best be organised and integrated into formal local government organisations (ICIS 2014). This is planned to be done by reviewing experiences of "urban labs", and conducting action research in five European cities (see sub-section 4.2). URB@EXP identifies urban labs to be the same as living labs and city labs, and defines them as an approach, in which local governments engage in solving problems together with other stakeholders in urban development (JPI Urban Europe 2014c).

URB@EXP started recently (September 2014), and it has not yet generated much research material. However, it is nevertheless useful to analyse how the project defines ULL and seeks to operationalise the concept. The key research questions posed by the project are: 1) What determines the agenda setting for urban labs? 2) What are their conditions for success? 3) How can they be integrated in the existing structure of urban governance? (Kemp 2014).

4.2 Variety of urban living labs

All projects presented in sub-section 4.1 apply an ULL approach either to explore existing urban infrastructure and potentially contribute to solutions to existing challenges in these areas, or to design and set up a new ULL. They thus focus on specific ULLs in European cities (Table 3). What is explored and achieved through the ULLs is quite diverse and depicts the broad range of activities and ambitions present in ULL across Europe. This includes sustainability and low carbon transitions in parallel with economic development and social issues.

Table 3. Urban living labs studied by selected European projects

#	Project	ULL case study	Country	What is explored/achieved through the ULL case study
	APRILab	An urban development project T3 in Espoo	Finland	The ULL approach is used to explore solutions to existing challenges: urban sprawl, a need for densification and creating a mixed-use area, development of public transportation (metro, light rails, buses)
		The South Harbour neighbourhood in Copenhagen	Denmark	The ULL approach is used to explore solutions to existing challenges: low attractiveness of disadvantaged areas, inequality in urban development and investments
		Aalborg East neighbourhood in Aalborg	Denmark	The ULL approach is used to explore solutions to existing challenges: segregation, mono-functional areas with big distances, unemployment, many living on welfare, low level of education among inhabitants
		Post-suburban development IJburg in Amsterdam	Netherlands	The ULL approach is used to explore solutions to existing challenges in IJburg: decreasing investments, stringent environmental regulations, environmentally sound water-land planning and accounting for a protected ecosystem of the IJmeer,

				changed living preferences of households
		Overamstel project area in Amsterdam	Netherlands	The ULL approach is used to explore solutions to existing challenges: urban intensification and integration of the area to the urban structure of the city, zoning and land use mix, business improvement, noise environmental zoning
2	**CASUAL**	A neighbourhood living lab in Vienna	Austria	The ULL on transport and mobility is created and managed to generate innovative ideas and scenarios for sustainable urban development
		A neighbourhood living lab in Stockholm	Sweden	The ULL on housing and lifestyle is created and managed to generate innovative ideas and scenarios for sustainable urban development
		ULL Färgfabriken in Stockholm	Sweden	An existing ULL, which is an exhibition and a meeting space for art, architecture and urban development, is a partner in the project and is studied as a reference
3	**Green/Blue Cities**	An international ULL in Kiruna	Sweden	The ULL approach is used to bring together citizens, practitioners, decision makers, and researchers, to jointly develop innovative solutions on green/blue infrastructure
		A national ULL	Austria	
		A national ULL	Netherlands	
4	**SubUrbanLab**	ULL "Shape your world" in Alby suburb of Botkyrka	Sweden	Creating an ULL to promote youth and urban gardening, and modernisation and social uplifting of suburbs
		ULL "New light on Alby Hill" on Alby hill of Botkyrka	Sweden	Creating an ULL to experiment with LED lighting to make an area more secure and attractive
		ULL "Vacant space Alby" in central Alby of Botkyrka	Sweden	Creating an ULL to use abandoned space for activities by residents
		ULL "Energetic cooperation" in Peltosaari district of Riimäki	Finland	Creating an ULL to decrease electricity consumption by providing smart meters to residents
		ULL "Sustainable decisions" in Peltosaari district of Riimäki	Finland	Creating an ULL to raise awareness about sustainable energy for decision makers
		ULL "Together more" in Peltosaari district of Riimäki	Finland	Creating an ULL to offer new house functions in a partially empty community building
5	**URB@EXP**	The Maastricht-LAB in Maastricht	Netherlands	Studying an existing ULL, which started in 2011 and implemented 8

				projects to tackle complex urban challenges (e.g. dealing with the issue of vacant property in the city)
		Stadslab2050 in Antwerp	Belgium	Studying an existing ULL, which started in 2013 and developed 15 project ideas on green space and nature in the city, and sustainable living and renovation; these were subsequently designed and implemented; new thematic challenges are considered
		City of Malmö	Sweden	The City of Malmö has been strongly involved in living labs hosted at MEDEA/K3, Malmö University. The City of Malmö does not currently run its own ULL but it is interested in exploring options to establish an ULL for new forms of urban governance and city development
		City of Graz	Austria	The City of Graz aims to gather the latest experience from Europe on how to involve citizens in city development to make urban areas more suitable to their needs and prevent social problems. Living labs are an integral part of the Smart City Graz Action Plan 2020
		City of Leoben	Austria	The City of Leoben sees ULL as necessary for a broader view on stakeholder needs and perceptions, and that it can help close the gap between politics and citizenship; the clarification on who will be the best candidates for ULLs is needed

5. Analysis

5.1 Characteristics of urban living labs

This sub-section seeks to answer *RQ 1: How is the urban living lab concept positioned in the theory on urban governance and articulated and applied by the ongoing research projects in Europe?* Overall it is found that ULLs are neither entirely new nor completely contiguous with past approaches. When analysing the insights from the theory and literature (section 3), and comparing them with the findings from empirical examples of ULL projects and cases in Europe (section 4), five key characteristics of ULLs can be identified: geographical embeddedness, experimentation and learning, participation and user involvement, leadership and ownership, and evaluation and refinement. Each of these is briefly discussed below.

First, ULLs are *placed in a geographical area* – they are predominately not virtual platforms, although they may utilise online tools. ULLs represent ecosystems of open 'urban' or 'civic' innovation, and are situated in a real urban context where the process in focus is taking place. This may be a region, an agglomeration, a city, a district or neighbourhood, a road or corridor, or a building. There are many possible urban configurations that can host an ULL, but the area is normally clearly defined and has a manageable scale.

Second, ULLs represent a specific form of *experimentation*, whereby processes of innovation and *learning* are formalised – unlike policy experiments and innovation niches. ULLs test new technologies, solutions and policies in real world conditions in highly visible ways, which can prompt radical social and technical transformation. An important component of this experimentation is the co-production of knowledge and ideas with the users, which is particularly indispensable when smart city initiatives are tested. By placing user-centred experimentation in its heart, the ULL is open to unexpected discoveries and learning that originates from the users. The topical range of the studied ULLs is, however, not biased towards smart city technologies. Only one ULL case (ULL "Energetic cooperation" in Peltosaari district of Riimäki) explicitly tests the use of smart meters by residents and its contribution to reduced energy consumption. Other ULLs apply user-centred experimentation to achieve a wider learning experience and exercise innovative forms of urban governance based on actor participation.

Logically the third characteristic of ULLs enters here: *participation and user involvement*. Participation and co-design with stakeholders such as residents and users is at the core and appears in all stages of the ULL approach – from identifying stakeholder needs, deciding upon ULL goals and visions, planning and designing to developing, implementing, evaluating ULL actions and updating ULL ambitions. The interaction process and methods should be differentiated accommodating the background and interests of different stakeholder groups. ULLs represent research and innovation processes within a public-private-people partnership (bringing together citizens, practitioners, decision makers, and researchers). This also means that research organisations and government funding bodies become more actively engaged in sustainable urban development to help address gaps in knowledge and finance. An important practical challenge for many ULL projects lies in how to achieve the inclusion of all key relevant stakeholders (both active and passive), account for their interests and thus re-politicise this new form of urban governance that corporate-led partnerships and scientific modes of governance might threaten.

This final argument feeds into the discussion of *leadership and ownership* of ULLs, the fourth key characteristic identified. The literature suggests that the ability of ULLs to contribute to urban sustainability and low carbon transitions depends on how they are designed and executed in practice, and it appears from the case studies that having a clear leader or owner is crucial for an ULL. There is an important coordination and management role for an ULL to be effective, although a delicate balance exists between steering and controlling. The ULL needs to remain flexible for different stakeholders to engage in its development and direction.

Finally, *evaluation* of the actions and impacts of an ULL is important to feed back the results, and revisit and refine the goals and visions over time. Evaluation underpins the ability of ULL projects to facilitate formalised learning amongst the participants.

5.2 Similarities and differences of urban living labs

This sub-section seeks to answer *RQ 2: How are ULLs in selected projects assembled and embedded, and in which ways their design is similar and varied across urban contexts?* Table 1 and Table 3 list the ULL projects analysed in this paper and provide information about their partners, geographical distribution and locations and topics of their ULLs. As the project titles show (Table 1), all of them address sustainable urban development, although the focus varies from planning and infrastructure to lifestyles and governance. The partners and partner countries demonstrate a strong bias towards Northern Europe and Scandinavia, which reflects a legacy of expertise in living lab approaches in these places. Finland in particular has played a key role in developing the living lab methodology over the past twenty years as a broad innovation tool for product and service development. The partners and partner countries also reflect the geographical distribution of expertise in sustainable urban planning, with Sweden and the Netherlands in particular strongly represented.

When analysing ULLs used by the selected projects (Table 3), four key topics are found relevant to discuss their similarities and differences:

- the ways in which ULL approach is operationalised;
- the type of partnership in ULLs and the role of research institutions in the ULLs;
- the types of challenges and topics addressed by different ULLs; and
- the role of sustainability, environment and low carbon agenda in ULLs.

First, all projects analysed in this article are driven by the needs to tackle existing urban challenges. They, however, have different goals and thus view the usefulness of the ULL concept/approach for their work in different ways. Some projects create and manage ULLs (SubUrbanLab, CASUAL, URB@EXP) while others apply the ULL approach (APRILab, URB@EXP) or some of its principles (e.g. participatory development of innovative solutions in Green/Blue Cities) to existing urban infrastructures to explore, if ULLs can be the way to address the pressing dilemmas in the cities and surrounding areas. URB@EXP project studies existing ULLs and experimentation activities in the partner cities to develop guidelines on the types of problems for which ULLs are most suited and how they can be best integrated into formal local government organisations while CASUAL and APRILab projects investigate the broader potential of ULLs for urban governance and planning. URB@EXP defines ULLs somewhat more narrowly than other projects by stressing that it is primarily local governments, who engage with other stakeholders to solve urban development problems.

Second, all projects are led by research institutions, which play central roles by driving the case study selection and defining visions for ULLs and their applicability, and also designing and setting up ULLs (e.g. CASUAL, URB@EXP). In three out of five preliminary selected cases of urban areas in the APRILab project the university campuses are located within the area (Aalto University in Espoo City, Aalborg University both in South Harbour of Copenhagen, and in Aalborg East area in Aalborg). Such a strong role of research institutions can be explained by the fact that all studied projects are funded by the JPI Urban Europe, which in its two first calls has heavily supported research (both basic and applied) and only to a certain extent innovation (essentially the funds provided by local funding bodies within this programme are insufficient to fund pilot or demonstration initiatives). This also may be one of the reasons why the private sector does not seem to be heavily represented in the ULLs used in the projects (only two projects have SME partners in their consortium: an exhibition and meeting space Färgfabriken in CASUAL, and a foresight and design studio Pantopicon in URB@EXP). Another explanation for the somewhat low representation of the private sector may be linked to the fact that most of the projects have started quite recently,

and may have not yet defined the partnerships for their ULL cases or have not disseminated the information about such partnerships. While all the projects demonstrate their strong connections to local governments and city actors, only two have city partners as the (funded) members in the consortium (SubUrbanLab and URB@EXP).

Third, the studied projects and their selected ULLs address a great variety of topics, which are driven by different urban sustainability challenges. These include the challenges of:

- urban planning (e.g. a need for densification, zoning and development of mix-use areas, development of public transportation in APRILab, low attractiveness of disadvantaged areas in APRILab and SubUrbanLab, planning for green space and nature in the city in URB@EXP);
- social development (e.g. segregation, unemployment, low level of education among inhabitants in APRILab);
- economic growth (e.g. decreasing investments in APRILab, a need for business development in APRILab and SubUrbanLab);
- environmental sustainability (e.g. handling storm water in Green/Blue Cities);
- consumption and lifestyles (e.g. changed living preferences of households in APRILab, questions of housing, mobility and sustainable lifestyles in CASUAL and URB@EXP).

Fourth, when discussing the role of sustainability, environment and low carbon agenda in relation to ULLs, only one project analysed in this article – the Green/Blue Cities - has a clear rationale to address the challenge of climate change. In APRILab project the low carbon agenda is explicitly mentioned only in the case of Copenhagen as the city aims to become sustainable and zero carbon in 2025 (Hansen *et al.* 2013). In SubUrbanLab project the topics of ULLs in Finland have a slightly more environment and low carbon perspective as two of them seek to decrease energy consumption and promote the use of sustainable energy.

When exploring how other environmental challenges are considered by the studied projects, in most APRILAb cases they do not have high priority, and are often presented as "add on" dilemmas. Only IJburg project in Amsterdam contains a strong environmental component, which is linked to water-land planning and the proximity of the protected ecosystem of the IJmeer (Hansen *et al.* 2013). The development of public transportation (light rails and metro) is central to T3 project in Espoo city (APRILab), which will have implications for reducing greenhouse (GHG) emissions, however, does not appear as a primary goal in the development of the area. The focus of CASUAL is clearly on sustainable and environmentally conscious consumption as it aims to explore how to promote sustainable living.

Despite the fact that the theory identifies climate change as a primary driver for ULLs in the domains of sustainability and low carbon, the trends above indicate that not all ULLs are designed with a low carbon rationale in mind but can also be oriented at promoting economic growth or enhancing social cohesion. As it can be seen from Table 3 and the discussion above, the topics often include modernisation and social uplifting of districts or regions, challenges of unemployment and social security, and economic development. (e.g. APRILab, SubUrbanLab, URB@EXP).

5 Discussion

There are at least two key areas that deserve further discussion. First, it appears that ULLs have become effective vehicles with which to secure funding. But reasons for this attractiveness and the financial stability of ULLs are open for debate. Second, there remain many questions about the impacts and effectiveness of ULLs both in their own geographical domain and more broadly at regional and national scales. For example, how do ULLs evaluate their own impacts? How do they feedback results and findings of evaluation to improve their activities and impacts? This article focuses on projects funded specifically by JPI Urban Europe. It is clearly important to go beyond these projects and look at other developments of ULL in Europe.

As previously identified, ULL have a growing appeal as they can attract European funding and in the case of JPI Urban Europe, it was even a specification of the call to utilise the ULL approach. This leaves open for discussion what kind of identity and vision initiatives would have taken if this was not the case. Similar projects in previous years have been funded by the European frameworks for innovation research and other national innovation funding agencies (e.g. Vinnova in Sweden). Overall, the explicit focus of funding bodies to target urban territories to implement the living labs approach, which has already a longer history in ICT innovation service delivery, seems to be rather new.

Looking at the time line and reflecting for a moment only about the financial mechanisms behind innovation research and sustainable urban development, many ULLs have emerged in the wake of the 2008 financial crisis. JPI Urban Europe was established in 2008 followed by the launch of similar initiatives that aim to accelerate urban innovation (e.g. Eurbanlab by Climate KIC). More mature cases report that cities struggled to invest after the financial crisis. Therefore new financial mechanisms and collaborative approaches were needed to enable socio-technical change. There are expectations that cities and local actors will play a more significant role in climate change actions in the coming decades. If this is to be the case, then greater funding for urban sustainability and ULLs is to be expected.

What has in recent years emerged as a conceptualisation of ongoing practice, motivated by sector crisis and/or strong sustainability visions, now seems to have become a formalised process driven by institutions. The aim of JPI Urban Europe is to "create attractive, sustainable and economically viable urban areas, in which European citizens, communities and their surroundings can thrive". At the moment, very little is known about private sector involvement in the ULLs presented in this article. In particular, if and how solutions and socio-technical change will be economically viable and embedded beyond the funding period offered by JPI Urban Europe. The long-term engagement by the private sector is needed to support ULLs but there are trade-offs if ULLs become too dependent on private sector funding and interests.

ULLs often seek to expand their "ecosystem" to broader knowledge sharing networks, such as the International Sustainable Campus Network (ISCN) and the European Network of Living Labs (ENoLL). These networks are co-evolving with ULLs as they provide a platform to develop and share standardised evaluation criteria, offering services to members with benefits through guidance, increased visibility and therefore a broader impact generation. JPI Urban Europe further provides a platform to co-create a joint research strategy and build links between relevant stakeholders. ENoLL, ISCN and JPI Urban Europe provide a vital web between and across ULLs to ensuring learnings are shared and utilised. However, there is also a need for further investigations how ULLs utilise such networks and the extent to which lessons and insights can spread through the networks.

Since the projects and ULLs funded by JPI Urban Europe are diverse in their approach and challenges they seek to address, a standardisation of evaluation criteria, as provided by the ISCN, might not lead to the intended outcome. Continuing the approach of co-creation and experimental learning, the evaluation of a project and application of the living labs approach may be a better subject for the people involved and affected by the project in order to maintain resilience and

overcome potential lock-in created by the underlying initial vision. This is a dynamic process and will probably evolve over time, but thinking about the resilience and adaptability (and as such eventually avoiding sunk funding costs of a project) it seems important to look ahead and ensure space for co-creation remains embedded into urban governance into the future.

6 Conclusions

This article examined how the ULL concept is being operationalised in contemporary urban governance for sustainability and low carbon cities by exploring five projects funded by the JPI Urban Europe covering 22 examples of ULLs. As suggested, ULLs are emerging as a form of collective urban governance and experimentation to address a range of sustainability challenges experienced in cities and urban areas and to capture opportunities created by urbanisation. Key characteristics of ULLs identified in this article include: geographical embeddedness: experimentation and learning; participation and user involvement; leadership and ownership; and evaluation and refinement. Through analysing the ULLs used by the selected projects, four key topics are found relevant to discuss their similarities and differences: the ways in which the ULL approach is operationalised; the type of partnership in ULLs and the role of research institutions; the types of challenges and topics addressed by different ULLs; and the role of sustainability, environment and low carbon agenda in the ULLs. What is clear across the cases is that ULLs are bringing existing constellations of urban actors together in new ways to create more collaborative and experimental ways of 'doing' urban development. A key question warranting further research involves the extent to which this way of doing urban development extends beyond individual projects to become embedded in existing modes of governance.

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