Urban Living Labs on Food, Water and Energy Evaluative Scheme & Manual

This project has received funding from the Netherlands Organisation for Scientific Research

Netherlands Organisation for Scientific Research

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 730254.

This manual is one of the deliverables of the GLOCULL project. GLOCULL stands for: Globally and Locally sustainable Food-Water-Energy Innovations in Urban Living Labs. GLOCULL is funded under The Sustainable Urbanisation Global Initiative (SUGI) call on the food-water-energy nexus by JPI Urban Europe and the European Union's Horizon 2020 research and innovation programme under grant agreement number 730254. The following national funding agencies co-financed the GLOCULL project: NWO (the Netherlands), FFG (Austria), FAPESP (Brazil), BMBF (Germany), FORMAS SWEA (Sweden), NSF (USA) and START (USA/Africa).

GLOCULL is a collaborative project with academic partners from: MSI (former ICIS) – Maastricht University, LUCSUS-Lund University, School of Public Health- University of Sao Paulo, BOKU – University of Natural Resources and Life Sciences Vienna, Arizona State University, Stellenbosch University, and Leuphana University of Lüneburg.

Referencing: Offermans, A. (ed), N. Forrest, D. Wahl, M. Dalla Fontana, P. Bernert, F. Moreira, T. Mitrofanenko, A. Gcanga, B. Wlcek, C. Mikovits, and J. Baumgartner (2020). Urban Living Labs on food, water and energy: evaluative scheme and manual. GLOCULL project 2018-2021 JPI-Urban Europe

Contents

Introduction to the manual

Challenges in food, water and energy systems are locally and globally connected. For local actors, including cities, it is difficult to anticipate whether solutions to one issue in the food-water-energy nexus (FWE-nexus) are sustainable across food, water and energy systems, both at the local and the global scale. The GLOCULL project therefore aims to develop an Urban Living Lab approach for innovations in the FWE nexus that are locally and globally sustainable. To support future implementation of this approach, guidelines and a participatory assessment tool kit will be developed through co-creation in seven Urban Living Labs (see figure below), based on an integrated assessment of local-global interactions in the FWE nexus and transdisciplinary action-research in the local Living Labs. We developed an *evaluative scheme* as a learning tool to be used in the Urban Living Labs, but also as a way to describe and evaluative different living labs.

The evaluative scheme itself can be found on page 11-18. The scheme consists of six themes (setting, general profile, inputs, process, outputs, and outcomes) consisting of 5-7 constructs each. In this manual, the themes and constructs will be explained, and example answers to the constructs are given.

Research of, and researcher's involvement in, living labs is not entirely new and scholars have been publishing about living labs before. As we did not want to reinvent the wheel, our evaluative scheme heavily relies on a sophisticated scheme proposed by Christopher Lüderitz and others in 2017[1]. We adapted their scheme to be better applicable to the food- water-energy nexus and to more explicitly differentiate between the *context* in which a lab is embedded, the *constellation* of the lab, and the experiment(s) lying at the core of the lab (see page 10).

During a GLOCULL project meeting in Stellenbosch in November 2018, the project team developed a series of questions to be used to either describe or evaluate the different components in a living lab (i.e. the context, the constellation and the experiment(s)). The originally formulated questions are brought together in an overarching guiding question and constructs, which can be found in the tables on pages 11-18. Questions and example answers are both drawn from the article by (Luederitz et al., 2017) and from the seven Urban Living Labs lying at the core of the GLOCULL project. More information and an application of the evaluative scheme to the living labs, can be found in (Offermans et al., 2019).

For who is this manual?

This manual has the aim to assist Living Lab participants in the (co-)design and evaluation of their living labs and innovations. The manual can therefore be used in a close collaboration between action researchers in a living lab and involved stakeholders (e.g. practitioners). The manual is not intended to be used by practitioners without the involvement of researchers, and neither as an innovative academic tool to be used by researchers alone.

While our experience is mostly focused on urban areas and closely related to linkages between food, water and energy systems, we believe that the manual could be applied also in the context of rural areas and in other thematic fields.

Moreover, in our experience, teamwork and bringing together knowledge and competences from different actors is crucial to designing, facilitating and evaluating living labs. Thus, we strongly encourage collaboration among different scientific disciplines and non-academic experts, as well as local and case-specific actors.

How to use the scheme?

The scheme provides a comprehensive understanding of aspects relevant to the successful design of urban living labs and the conduction of real-world experiments. In this context, the scheme is used as

[1] Luederitz, C., Schäpke, N., Wiek, A., Lang, D., Bergmann, M., Bos, J., Burch, S., Davies, A., Evans, J., König, A., Farrelly, M., Forrest, N., Frantzeskaki, N., Gibson, R., Kay, B., Loorbach, D., McCormick, K., Parodi, O., Rauschmayer, F., Schneidewind, U., Stauffacher, M., Stelzer, F., Trencher, G., Venjakob, J., Vergragt, P., von Wehrden, H., Westley, F. (2017). Learning through evaluation – a tentative evaluative scheme for sustainability transition experiments. *Journal of Cleaner Production* 169: 61-76

- a reference for reflection of the lab and experiment design as well as the context surrounding (and possibly impacting) the lab; it helps the researchers to identify inputs needed, plan out processes, i.e. research design, and anticipate outputs and outcomes, i.e. define goals.
- A shared reference for the comprehensive documentation of activities undertaken over the course of the lab and experiment phases
- As a reference for assessing and appraising the accomplishments of the Lab and the outcomes/outputs of experiments
- A basis for cross-case comparison with other Labs that have also employed this scheme between labs, context, and experiment. (for some kind of higher level learning?)

How to fill it out, and how to use it afterwards?

- The application of the scheme is meant as an iterative exercise, to be regularly edited and updated as progress advances in both the Lab and the experiments. The scheme itself can be used as a way to monitor the evolution and learning taking place in the Lab.
- As many constructs of Labs are both externally dynamic and internally negotiated it is expected that answers to many of the constructs will change, develop, and deepen over time. The scheme is designed to be flexible in order for specific constructs to be prioritized according to the goals of the Lab and experiment.
- The questions provided by the scheme are intentionally generic as they are designed to be applicable in different labs and for different experiments. That means that the questions provide a first guidance to collect data and assume an evaluative perspective on a given case. In some cases, it can be helpful to further specify or adapt these questions. It is crucial to document this process to ensure the comparability of results.
- The data collected through the scheme application is raw allowing for application and analysis toward a diversity of specific research questions. For further analysis of specific aspects, it may be necessary to increase the quality of the data.
- If using the scheme for cross-case comparison, it may be useful to align the use of the evaluative scheme between cases, with agreement on meanings, depth of response, and the number and staging of scheme iterations.

Our approach to a Living Lab

Since 2011 we see rapidly increasingly numbers of peer reviewed publications with the concept “Living Lab(s)” in the title. Since 2016 we also see an increase in numbers of publications on living labs that specifically mention the word “Sustainable” (see Offermans et al., 2019). But what does a Living Lab entail, why is it useful for sustainability issues and how does it differ from concepts we already knew about and adopted before 2016? Although the angle taken towards, and the definition given to, Living Labs differs across publications we can describe Living Labs as “*participatory platforms for open innovation that* *support experimentation with real users in real contexts. Living labs can be understood both as a methodology and as a space for user participation in innovation processes*" (Scholl et al., 2017, p. 10)[2].

We adopted a multilevel perspective to build the evaluative scheme by applying three layers of analysis: the context in which the living lab and the experiment(s) are embedded; the urban living lab itself; the experiment(s) (see Fig.1).

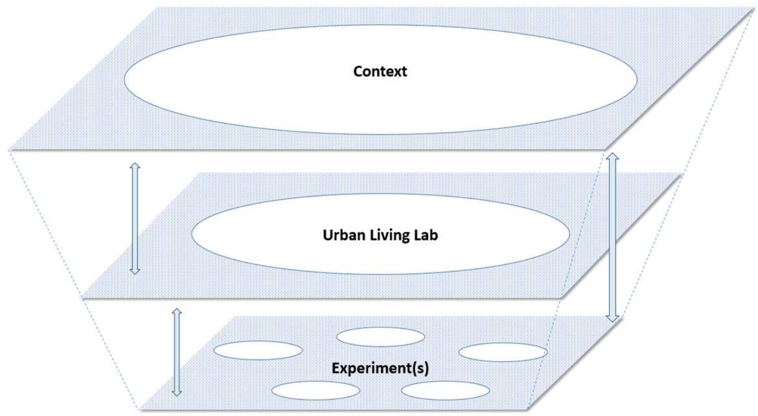


Figure 1: layered character of the Living labs.

The context: this level of analysis focuses on the setting in which the urban living lab and the experiment(s) take place. In this section we look at the general contextual factors (of different nature) that significantly influence the overall purpose of the lab or the specific design, outputs, or outcomes of the experiments.

The Urban Living Lab: this second layer is central in the evaluative scheme. The scope is internal as the objective of the analysis is the constellation of the lab itself. It includes a set of general information that characterize the lab, its purpose, structure and organization. Further information is provided about: the different elements that are invested, used, applied, or otherwise put into the lab (inputs); how the activities are conducted in the lab (process); what changes are directly generated by lab activities (outputs); and what impacts have the lab's activities on the broad sustainability of society (outcomes).

The experiment(s): at this level, the analysis narrows the focus to the experimental project(s) that are developed in the lab. The analysis largely reproduces the same structure applied at the lab level: inputs, process, outputs and outcomes.

It is important to highlight that despite information and data can be collected for the three layers independently, what it is included at the context, lab and experiment(s) levels should be interrelated.

[2] This paragraph comes from the GLOCULL Midterm report (see Offermans et al., 2019).

The Evaluative Scheme

SETTING (Context Level - external to the lab)		
What are the general contextual factors that significantly influence the overall purpose of the lab or the specific design, outputs, or outcomes of the experiments the lab conducts?		
Construct	**Guiding Question (descriptive analysis)**	**Answer**
Environmental	What environmental factors (biological or physical), if any, such as climate, soil type, or vegetation, significantly influence the lab's purpose or activities?	
Social/Cultural	What socio-cultural factors, if any, of populations or sub-populations, such as diversity, education, income, health, language, religion, values, beliefs, and social norms, significantly influence the lab's purpose or activities?	
Financial/economic	What financial/economic factors, if any, such as funding sources, financing mechanisms, taxes, diversity of enterprises, unemployment, and diversity of workforce, significantly influence the lab's purpose or activities?	
Technical/ Infrastructure	What technical or infrastructure factors, if any, such as water and energy infrastructure, transport networks, housing stock, other built environment, and green infrastructure, significantly influence the lab's purpose or activities?	
Legal/Political	What legal or political factors, if any, such as laws, regulations, standards, permits, dominant ideology, activism, public participation, significantly influence the lab's purpose or activities?	
Organizational/ Capacity	What organizational or capacity factors, if any, such as knowledge, skill, organizational structures, networks, training programs, and support services, significantly influence the lab's purpose or activities?	

GENERAL PROFILE
(Lab Level)

What is the general purpose, structure and composition of the lab?		
Construct	**Guiding Question (descriptive analysis)**	**Answer**
Location and Scope	Where is the lab located and what is the geographical scope of its activities?	
Purpose	What is the purpose of the lab and what is its experimentation about, specifically with respect to FWE? Does it have, for example specific goals, and are these formally defined?	
Activities	What are the main activities of the lab, such as experimenting, outreach, or training?	
Timeframe	What is the timeframe of the lab's operations?	
Organizational Structure	What is the organizational structure of the lab and experiments conducted within it?	
Participants	Who are the primary participants (operators, partners, sponsors, etc.) in the lab and experiment activities?	
Background and History	How and when did the lab come to exist?	

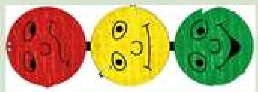
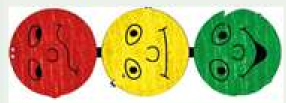
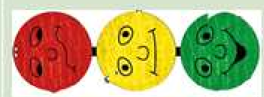
INPUTS (Lab / Experiments Level - internal to the lab)		
What elements - physical, financial, social, emotional or other - were invested, used, applied, or otherwise put into experiments and other lab activities?		
Construct	**Guiding Question (descriptive analysis)**	**Answer**
Awareness	What is the general awareness of lab participants of the need for radical real-world changes in line with the lab's purpose?	
Commitment	What is the commitment of lab participants to pursue the lab's purpose, fully engage in experiments and complete tasks or activities to the best of their ability, and what is the basis of such commitment (i.e. what is the motivation)?	
Capacities (Expertise)	What are the relevant skills, experience, and knowledge of participants with respect to the activities of the lab?	
Trust	What degree of trust exists between participants: to what extent are they willing and able to have open, truthful and collaborative exchange, to speak one's mind, and rely on others' judgments and capacities?	
Support	What support (structural, financial or nonfinancial resources) is available to participants to plan and conduct the experiments or other lab activities, such as funding, staffing, facilities, equipment, endorsements, and under what conditions is this support provided (unconditional/full control, in-kind contributions, extension of existing responsibilities, voluntary, etc.)?	

PROCESS (Lab / Experiments Level - internal to the lab)		
What is the approach and methods used within the lab and what is the rationale for how this will achieve the lab's aims?		
Construct	**Guiding Question (descriptive analysis)**	**Answer**
Experimental procedure	What actions are taken to produce the experimental results and in what order, and in how far is this structured, planned, and managed?	
Transformational Rationale / Methodology	What general approach and specific methods does the lab use in experiments and other lab activities, and what is the overall rationale for how this leads to transformational change?	
Transdisciplinarity	How do different participants collaborate in different experimental phases (planning, design, recruiting, etc) or other lab activities (e.g. decision making, communicating), in what settings, on what terms, and to what intensity?	
Reflexivity and learning	How is learning, and to what order (e.g. first, second, third), a part of experiments and other lab activities? For example, is there a shared learning agenda, specific events for reflection, or ability to adapt the experimentation process?	
Openness and transparency	How is the process, data, decisions, results and other information made available to all participants and to what extent does this ensure all participants are equally informed and avoids exclusion or marginalization due to unequal knowledge?	

OUTPUTS (Lab / Experiments Level - internal and external to the lab)		
What changes were generated, inside or outside the lab, as a direct result of the lab activities?		
Construct	**Guiding Question (descriptive analysis)**	**Answer**
Capacities	To what extent do lab experiments empower participants to act sustainably in everyday decision-making and practices through educating them in cognitive, practical and interpersonal competencies and internalizing required skills, and activating new behavioral patterns?	
Knowledge	To what extent do lab experiments generate evidence-supported (tested) instructions for effectively solving a sustainability problem within the defined experimental setting including guidelines on how to most effectively transition from the current to the desired state?	
Accountability and Commitment	To what extent do experiments ensure confidence and commitment of participants to implement results generated by the experiment and their dedication to positive change?	
Physical structures	To what extent do experiments create new or transform existing buildings, infrastructures, technologies and products that are radically different from existing ones?	
Social structures	To what extent do experiments Create new or transform existing networks and organizations, values and norms, rules and policies, behavior and practices, and discourses that are radically different from existing ones?	
Uptake (transfer and scaling)	To what extent do experiments create generalizable lessons about how to achieve similar outputs and outcomes in different contexts or that facilitates the up-take of experiment results at larger scales?	

OUTCOMES (Lab / Experiments Level - external to the lab)		
What impacts have the lab's activities had on the broad sustainability of society both within and beyond the immediate scope of the lab; what are the impacts on food, water and energy flows and the nexus?		
Construct	**Guiding Question (descriptive analysis)**	
Socio-ecological integrity	In what ways do the outputs of experiment(s) lead to greater harmony of human well-being with ecosystems, prevent degradation of ecosystems, and reduce impacts and threats to the biophysical life-support system? *(See detailed FWE Outcomes scheme in section 6.1.2 and next page).*	
Livelihood sufficiency and opportunity	In what ways do the outputs of experiment(s) lead to sufficient access of individuals and communities to what is needed for a decent life and create opportunities for positively exercising power and capabilities? *(See detailed FWE Outcomes scheme in section 6.1.2 and next page).*	
Intra- and intergenerational equity	In what ways do the experiment(s) lead to a reduction in gaps between the rich and the poor and enhance opportunities of future generation to pursue sustainable lives? *(See detailed FWE Outcomes scheme in section 6.1.2 and next page).*	
Resource maintenance and efficiency	In what ways do the experiments(s) lead to sustainable livelihoods for all while reducing threats that jeopardize the long-term socio-ecological integrity and cutting material and energy use per unit of benefit? *(See detailed FWE Outcomes scheme in section 6.1.2 and next page).*	
Socio-ecological stewardship and democratic governance	In what ways do the experiment(s) lead to individual and collective sustainability decision-making that fosters ongoing collaborative actions, social inclusion and ownership?	
Precaution and adaptation	In what ways do outputs of experiment(s) lead to acknowledging uncertainty, avoiding uncomprehended risks, creating learning opportunities and preparing for surprises and change?	

Food-Water- Energy detailed outcomes section

	Food	Water	Energy
Food	How does the experiment impact the quality and quantity of (resources to grow) food? This includes changes in the access to and (inter- and intra-generational) distribution of food and resources to grow food. It also includes impacts on food surpluses, food waste and the consumption of food. 	What are feedbacks or tradeoffs in the water and/ or energy domain resulting from the experiment and/or the benefits mentioned under "food"?	
Water	What are feedbacks or tradeoffs in the food domain resulting from the experiment and/or the benefits mentioned under "water"?	How does the experiment impact flows of water (quantity and quality)? This covers changes in the distribution of flows (inter- and intra-generational), access to water, the regenerative capacity of water bodies, wastewater and water demands. 	What are feedbacks or tradeoffs in the energy domain resulting from the experiment and/or the benefits mentioned under "water"?
Energy	What are feedbacks or tradeoffs in the water and/ or food domain resulting from the experiment and/or the benefits mentioned under "energy"?		How does the experiment impact changes in energy flows (quantity and quality), including access to energy, energy security, (inter- and intra-generational) distribution of access and security. It also covers impacts on the surplus of energy, energy spillage, energy demands, and the balance between the use of renewable and non-renewables resources.  [3]

[3] The traffic light figure is derived from: https://educadora-webshop.nl/stoplicht-gedragsmeter/?gclid=CjwKCAiAy9jyBRA6EiwAeclQhMP_13InbYBXSagH7v3Kp3-z-4_vp_5zkPdHBGJ1_r9NscJvFTeHWhoCLngQAvD_BwE

1. Manual on the Setting

Written by Tamara Mitrofanenko, Bernhard Wlcek, Christian Mikovits, and Johann Baumgartner (BOKU)

1.1 General description on the setting

We often experience and conclude that the way projects and experiments turn out (i.e. implementation, outputs and, eventually, outcomes) is context dependent. In fact, many general factors can significantly influence the "living lab" – and they should be considered when thinking about the overall purpose of the lab and developing the specific design of the experiment. The initial part of the framework contains six constructs, meant to facilitate deliberation on the contextual factors – the "setting" for the lab and the experiments:

1. Environmental factors
2. Social/Cultural factors
3. Financial/Economic
4. Technical/Infrastructure
5. Legal/Political
6. Organizational/Capacity

While the above can be considered "external factors", providing the framework for our planned activities, they also closely interact with the other (living lab-specific) factors, related to the general purpose and structure, methods, inputs, outputs and outcomes of the lab, described in the sections 2.0-6.8.

1.2 Environmental factors

1.2.1 Description of the construct

Urban Living Labs (ULLs) or just Living Labs (LL) (which could also take place in a rural environment) are embedded in a real-life system, and thus are not isolated from the environmental (biological or physical) factors, which may influence the set up and activities of the lab, and the experiments. These factors and their interaction with the ULL should be carefully considered.

Guiding questions could include:

- What environmental factors, if any, such as climate, soil type, or vegetation, significantly influence the lab's purpose or activities?
- What is the geographical/ environmental/ physical setting of the experiment?

1.2.2 Data for answering the questions

Making a simple system map will help to establish a preliminary understanding of the main environmental factors, which may have an influence on the ULL. Depending on the identified factors, different types of data may be needed, including background information from literature, case-specific knowledge of the local actors, and potentially technical measurements.

1.2.3 Potential difficulties

While at the first glance the general influence of environmental factors might seem obvious, more rigorous consideration of technical aspects might be necessary in order to have a more precise understanding of the system. Also, when working in an interdisciplinary team, colleagues from different disciplinary backgrounds might have contrasting understanding of which factors might be more important and how to measure them.

1.2.4 Example answers

- Climate might influence the lab activities in the following ways: __ __; in the previous experience of the local actors, temperature and the amount of sunlight had a substantial influence due to __ __.
- A well-founded answer would just be possible with a thorough literature research. To which extent the question is relevant also depends on the literature findings about the environmental factors.

1.2.5 References

- Aroca-Delgado, Pérez-Alonso, Callejón-Ferre, and Velázquez-Martí (2018)
- Dupraz et al. (2011)
- Marrou, Guilioni, Dufour, Dupraz, and Wery (2013)
- Forrest, Stein, and Wiek (2019)

1.3 Social/Cultural factors

1.3.1 Description of the construct

ULLs inevitably involve people, local actors and case-specific experts, as well as other stakeholders, and might have indirect effects on wider groups of people. Moreover, social discourse, awareness and attitude may affect the ULL. As such, socio-cultural factors will likely play an important role, and should be carefully considered. Moreover, the historical context, in which the ULL takes place, may also play a role, i.e. with respect to relationships among the actors and their prior experiences related to the ULL activities.

Guiding questions could include:

- What socio-cultural factors, if any, of populations or sub-populations, such as diversity, education, income, health, language, religion, values, beliefs, and social norms, significantly influence the lab's purpose or activities?
- Which individuals and groups are involved and affected by the ULL activities?
- What is the context of the experiment (history, embedding)?

1.3.2 Data for answering the questions

Demographic data may be useful. Moreover, stakeholder and network analysis may potentially help to address this question, as well as conflict-analysis. Also, considering the historical aspects of the societal problem the LL is aiming to address, particularly with respect to the local context, could be essential to identifying and understanding social and cultural factors.

1.3.3 Potential difficulties

Socio-cultural factors can be highly complex and difficult to identify, especially those indirectly connected with the ULL. It may not be clear at the beginning, which actor groups and which individuals might exert more influence on the ULL. Moreover, various individual and social factors influence each other, and thus the local, regional and global policy context should be considered in this respect

1.3.4 Example answers

- Our main stakeholders are: ____, their current state of knowledge about the ULL appears to be ____; their attitudes/concerns towards the planned ULL/experiment are: ___. They are motivated to participate in the ULL because of: ___.
- The following actors are likely to influence the ULL, its outputs and outcomes: ____, due to the following personal (___), professional (____), and political (___) context.

1.3.5 References

- Enengel et al. (2012)
- Forrest et al. (2019)

1.4 Financial/economic

1.4.1 Description of the construct

Financial and economic factors play an important role in enabling/inhibiting the ULL and the experiment to be carried out, ensuring enough resources for the implementation of the experiment, and also sustainability of the results. This entails resources directly related to the implementation: staff costs of the involved organizations, potential compensation for the stakeholders taking part in the ULL, as well as costs related to equipment, consumables, maintenance and organizational issues – as well as the potential of the experiment and its results to benefit the stakeholders financially (or on the contrary).

Guiding questions could include:

- What financial/economic factors, if any, such as funding sources, financing mechanisms, taxes, diversity of enterprises, unemployment, and diversity of workforce, significantly influence the lab's purpose or activities?
- What are the envisioned operation al expenses of the lab?

1.4.2 Data for answering the questions

Some of the data might be determined by the rules and regulations of the funding used for the implementation of the ULL. Demographic data could be useful, as well as information about the market circumstances - prices of good/resources and services, tariffs and economic regulations, with which the

ULL is concerned. Changes of the economic and financial environment during the operating time may also need to be considered by means of a sensitivity analysis.

1.4.3 Potential difficulties

Financial/market conditions and economic effects of the experiment can be strongly interrelated with socio-cultural and physical (i.e. climate) factors, and should not be considered in isolation. This inter-dependency makes them highly uncertain.

Often the economic/financial factors are highly site-specific, so the purely monetary economic outcomes of a ULL may not be easily transferred to other sites.

Moreover, financial factors/availability of the resources in the future may determine whether the results/outputs of the ULL will be sustained after the funding period is over.

1.4.4 Example answers

Financial and economic considerations contribute to motivation of the stakeholders to take part in the ULL, due to the fact that the results might help them to save costs and yield additional economic/financial benefits. Moreover, using renewable energy sources and more energy efficient methods of production could help them market their products in the future.

The following factors may influence the economic sustainability of the experiment: market circumstances, subsidy policies, properties of the material, costs of purchasing, installation and maintenance, opportunity costs, rate of electricity self-consumption, consumer electricity prices, life expectancy of the PV installation due to increased panel degradation, when operated in an agricultural environment on the one hand and a potential decrease in crop yield due to shadowing or area occupied by PV panels on the other hand.

1.4.5 References

- Forrest et al. (2019)

1.5 Technical/Infrastructure

1.5.1 Description of the construct

The role of technical and infrastructural factors depends on the nature of the experiment. In some cases, technical set-up can be more complicated and cumbersome, and can pose barriers for the initiation, implementation and continuation of the lab. This of course might also have financial consequences. In addition to the local and site-specific technical factors, relevance of the infrastructure on the city/regional/and potentially even national level should be considered.

Guiding questions could include:

- What technical or infrastructure factors, if any, such as water and energy infrastructure, transport networks, housing stock, other built environment, and green infrastructure, significantly influence the lab's purpose or activities?
- What is the technological/ infrastructural setting of the project?

1.5.2 Data for answering the questions

As technical and infrastructural factors are highly site-specific and may also be variable throughout the operating time, sufficient expertise and flexibility to cope with emerging issues needs to be ensured by the implementation team. The following data might be relevant: density of PV-panels relative to agricultural area, produced electricity over time – especially seasons, consumed electricity at specific times, crop yields.

1.5.3 Potential difficulties

Technical set-up could prove complicated and lead to delays in data collection, as well as time and financial shortages. There also exists the risk of sensors failing. Moreover, it is important to consider the fate of the technical set-up (after the experiment/project is finished) in the beginning of the ULL, and to make sure enough time and resources are allocated for its management and maintenance, as required.

1.5.4 Example answers

We are dealing with placing PV panels on a greenhouse - while planning at the demonstration object we faced several difficulties placing solar panels / additional infrastructure on top of greenhouses, which are in general meant to be mounted on top of regular roofs: the weight of the panels have to be considered, the weight of workers and machines during the installation require thorough planning and finally the given structure size of the metal frames, which define the size of one panel.

The density of the PV panels has to coincide with the plants: some plants, such as tomatoes, need a high amount of sunlight throughout the year, and some, e.g. cucumbers, need more shading, hence a balance between how much energy and how much sunlight is needed has to be calculated.

1.5.5 References

- Dinesh and Pearce (2016)
- Dupraz et al. (2011)
- Marrou, Wery, Dufour, and Dupraz (2013)
- Forrest et al. (2019)

1.6 Legal/Political

1.6.1 Description of the construct

The legal and political context (i.e. laws, regulations, standards, permits, dominant ideology, activism, public participation), in which the ULL is embedded, determine/frame the scope of its activities and its potential impact. Policy –related and legal factors might affect the economic/financial context of the experiment, (such as the availability of funds for follow-up on the ULL outputs), as well as institutional capacity.

Guiding questions could include:

- What legal or political factors, if any, such as laws, regulations, standards, permits, dominant ideology, activism, public participation, significantly influence the lab's purpose or activities?
- What is the political and legal setting of the project??

1.6.2 Data for answering the questions

Information about the legal and strategic documents, laws, rules and regulations, which frame the ULL, information about relevant policies on the local, city, province, national and regional levels.

1.6.3 Potential difficulties

There may be city-wide or national regulations, which limit the potential scope of the experiment. Existing policies may put a potentially innovative solution at a disadvantage due to alternative priorities (i.e. hydrogen power rather than photovoltaic).

1.6.4 Example answers

The city, where the ULL is based, has the strategy related to special planning, which challenges the proposed innovation, due to….

There is a national regulation with respect to land use, which limits the scope of technological application of the ULL/implementation of the experiment.

1.6.5 References

- M. Wolfram, Frantzeskaki, and Maschmeyer (2016)

1.7 Organizational/Capacity

1.7.1 Description of the construct

Organizational/capacity factors concern individuals and institutions involved in the ULL or influencing it indirectly/affected by it. They include, for example knowledge, skills, organizational structures, networks, training programs, and support services. A relevant consideration at the design stage of the ULL is which individuals and institutions who should/would be involved, and which opportunities and constraints this might imply for the implementation of the experiment, as well as sustainability of its result.

Guiding questions could include:

- What organizational or capacity factors, if any, such as knowledge, skill, organizational structures, networks, training programs, and support services, significantly influence the lab's purpose or activities?

1.7.2 Data for answering the questions

Information about the individuals (i.e. their experience, knowledge and skills, as well as networks), as well as institutions (structure, functions, mission) which are/should be involved in the ULL in order to facilitate its successful implementation and outcomes, as well as learning from it.

1.7.3 Potential difficulties

It is possible that as the ULL evolves additional skills and knowledge are needed, which might not be represented by the original implementation team, while involving additional experts might imply the need for additional resources.

Organizational structures (i.e. bureaucracy or administrative rules and regulations) might pose barriers to the implementation of the ULL. Moreover, organizations and individuals, who possess the needed skills and capacity for the ULL might not be available or interested to participate.

1.7.4 Example answers

The structure of the organization involved in the implementation of the ULL is conducive to the dissemination of the results, and initiating societal discourse about the sustainability challenge it is trying to address. Specifically, it facilitates the above via the following activities: ____.

Availability of expertise in the field of Agro-Photovoltaics, as well as in the field of public acceptance of renewable energy infrastructure, is important to render the experiment more meaningful for sustainable energy transitions.

1.7.5 References

- Forrest et al. (2019)
- M. Wolfram et al. (2016)
- M. Wolfram (2016)

2. Manual on the General Profile

Written by Darin Wahl (LUCSUS)

2.1 General description on General Profile

Here we move from the external context in which the lab sits to the constructs, actors, and framings that make up the internal context of the lab. Formal and informal agreements among partners, their roles, and a shared problem understanding are crucial here. This section will develop and gain detail while the lab evolves. The general question that we aim to answer with this section is: *What is the general purpose, structure and composition of the lab?* There are seven constructs within this section:

1. Location and Scope
2. Purpose
3. Activities
4. Timeframe
5. Organizational Structure
6. Participants
7. Background and History

2.2 Location and Scope

2.2.1 Description of the construct

Urban Living Labs are based in a specific physical geographical location. The activities of the lab, including experiments, will have relevance to and impact on this location. In this construct we target the bio-physical system boundaries in which the lab activities will take place, including the biophysical scope of the changes the lab intends to instigate.

Guiding questions could include:

- Where is the lab located and what is the geographical scope of its activities?
    - Where is the living located (where does the experiment(s) take place)?
    - Where are the real-world changes expected to take place?

2.2.2 Data for answering the questions

Part of the data for this question will be as simple as one or more physical addresses. However, the location of expected changes is less straight-forward. What specifically are you expecting to change, and what larger social-ecological-technical impact might your change have? You may need to consider making a simple system map that includes the reach of the systems in which you will intervene. Depending on the systems, you may need different types of data. However, as this is specific to physical systems, then if your project aims at e.g., energy use, data regarding the type and location of energy production your lab site engages with is required.

2.2.3 Potential difficulties
It is not always possible to know what changes your lab and experiment will trigger (uncovering these is often a point of experimentation), so this section can be revisited as your system map evolves along with the Lab.

2.2.4 Example answers
- Lab activities will primarily take place at this location: ---, while experiments will primarily take place at --- and ---. Meetings will take place in person at various convenient locations, or remotely through digital means.
- The experiments target the energy efficiency of the brewing process and will impact natural gas resources predominantly in southern Sweden.

2.2.5 References
- Forrest et al. (2019)

2.3 Purpose

2.3.1 Description of the construct
Labs are generally formed because actors from different fields have the opportunity to more clearly identify or address a problem in which they all have an interest. Once they are formed, labs must determine a strategy in which to engage with their problem to uncover novel pathways and/or knowledge. In this construct we target why the Lab was developed, what it proposes to do, for what outcomes. Guiding questions for this could be:

- What is the purpose of the lab and what is its experimentation about, specifically with respect to FWE? Does it have, for example specific goals, and are these formally defined?
    - What is the experiment about (what is the content of the experiment)?
    - What domains are involved in the experiment?
    - What is/ are the main focus (points) of the experiment (FEW)?

2.3.2 Data for answering the questions
Information for this section is largely from the negotiations, plans, and strategies developed between the project partners. There is little data that must be gathered; however, some labs choose to write formal agreements or have written project definition documents. This construct can inform the development of those documents.

2.3.3 Potential difficulties
Oftentimes the specific problem, approach to defining the problem, or proposed solutions of the actors are different. Actors can have different agendas and motivations, and therefore have different and perhaps conflicting goals. This diversity is an important aspect of the Lab approach, and the negotiation is a critical part of the co-development, co-design, and knowledge co-creation processes that produces the critical learning enabling sustainability transitions.

2.3.4 Example answers

- Overall purpose: To heighten awareness of sustainability issues, impacts and possible solutions in the Scanian craft beer industry. Co-develop sustainability principles for craft breweries and to experiment with solutions in line with those principles.
- Experiment - To determine the viability of (1) growing hops hydroponically in Swedish climate with (2) multiple harvests per annum; the potential of (3) using brewing production wastes: (3a) heat and (3b) CO_2, in the greenhouse; and to examine (4) parallel benefits in water and energy use efficiency in the brewery with the technical interventions needed for goal (3).

2.3.5 References

- Forrest et al. (2019)

2.4 Activities

2.4.1 Description of the construct

The Lab will develop specific actions and activities to develop and maintain the lab itself (co-design), and to initiate and manage the associated experiment(s). In developing the strategy for your lab there will likely be a variety of activities aligned with the different goals and hopeful outcomes of the lab. Activities can be both tangible, e.g. testing a technology, or intangible, e.g. gaining skills or competencies. A simple descriptive list of planned and anticipated activities can provide a useful overview as well as reveal gaps in your lab strategy. Guiding questions for this construct may be:

- What are the main activities of the lab, such as experimenting, outreach, or training?
- To what extent are the experiments independent or nested in the ULL?

2.4.2 Data for answering the questions

Information for this construct will come from the negotiations, plans, and strategies developed by the project partners. Keeping a record of the meetings (e.g. short minutes) might help in collecting data to fill in this section.

2.4.3 Potential difficulties

Many Labs have multiple phases, and it may be difficult to plan activities beyond the current phase. Also, there is the potential for a mis-match with Lab activities and the intended outcomes. It may be prudent to closely examine the plans for Lab activities to determine if they are strategically aimed at overall Lab goals and/or specific experiment targets. It is also often useful to critically examine how the activities will work together, and if there are missing elements that will be necessary in the short or long term. Consider how critical may be timing for some lab activities, and how long in advance so certain activities need to be scheduled and logistics arranged, including allocating funds. For example, preparing for planting seasons, permitting, and general municipal or institutional bureaucracy can be long processes.

2.4.4 Example answers

- Activities necessary to guarantee the overall ULL management (organizations of meeting, communication, negotiation, etc.).
- The main activity of the lab is to conduct a series of diverse "pilot projects" (experiments) with local enterprises, entrepreneurs, and other food economy actors.
- Initial (Phase 1) Lab activities: Capacity building workshops, sharing experiences from areas of expertise (co-learning, co-creation), building physical structures for experimentation, experimentation (to enable the 'purpose' as described above).
- The main activity of the lab is to conduct a series of diverse "pilot projects" (experiments) with local enterprises, entrepreneurs, and other food economy actors.
- Building a database of best practices from existing sustainable food business front-runners to transfer and scale solutions.
- 1 Workshops sections with the partners every 3 months.

2.4.5 References

- Forrest et al. (2019)

2.5 Timeframe

2.5.1 Description of the construct

Labs often take several years or more from conception to final outcomes. Furthermore, the experiments within the Lab may be either fast or slow in comparison to the overall Lab. Having a clear time-line will allow for the development of strategic markers and deadlines. Guiding questions can be:

- What is the timeframe of the lab's operations (including specific experiments)?
- Do the ULL timeframe and the experiments timeframe correspond?

2.5.2 Data for answering the questions

Information for this construct will come from the negotiations, plans, and strategies developed by the project partners. It may be also be delimited or constrained by funding and budgets.

2.5.3 Potential difficulties

It is possible that aspects of the project will last beyond the capacity of some partners to participate. It is also possible that Labs are planned for longer than their original funding will last. It is very likely that there will be expected or unexpected turnover of particular participants, which can severely disrupt a timeline.

2.5.4 Example answers

- Lab operations began in 2017 and have no planned end date, however current funding will end after spring 2021. Greenhouse construction in January 2020, for hydroponic experiment beginning March 2020 until winter 2022. All current partners have committed to this timeline.

2.5.5 References

- Forrest et al. (2019)

2.6 Organizational Structure

2.6.1 Description of the construct

The organizational structure of the Lab is the either formal or informal assumption of roles and responsibilities within the Lab. Labs are often driven by a few dedicated leaders or 'champions' who are the most highly motivated participants. There are however many aspects of Labs and the experiments they conduct. Determination of structure can be left to partner team leaders, or parceled out to specific individuals. Regardless, it is critical to have determined responsibilities for key outcomes of the Lab. It is often the case that particular partner teams will assume responsibilities for outcomes that are most relevant to their positions. While the analysis of data may be a shared responsibility, the write-up for academic publication will likely fall to the academic partner. Guiding questions for this construct may be:

- What is the organizational structure of the lab and experiments conducted within it?
- Who has the formal responsibility for the outputs and experimentation (including risks)?
- Does the project have a (co)-leader, and if so, what kind of person is this ("champion", level of commitment)?

2.6.2 Data for answering the questions

Information for this construct will come from the negotiations, plans, and strategies developed by the project partners. Keeping a record of the meetings and activities (e.g. short minutes) might help in collecting data to fill in this section.

2.6.3 Potential difficulties

Key complication in this area is personnel turnover. Having plans for transitioning responsibilities within teams and including other potential interested individuals can buffer this complication. Another complication can be competing responsibilities. People are busy, with multiple commitments. Oftentimes the exploratory nature of Labs can make Lab activities less of an urgency or priority for some partners. In these situations, a 'champion' can be effective in motivating action and progress.

2.6.4 Example answers

Lab responsibilities are shared between partners and regularly negotiated in the initial phase of the Lab. The overall lead or 'champion' of the Lab is currently the university partner. As experiments are carried forward, roles and responsibilities will be more clearly assigned especially concerning data collection and experiment monitoring.

2.6.5 References

- Forrest et al. (2019)

2.7 Participants

2.7.1 Description of the construct

The participants of the Lab are the core project partners as well as other actors who are important to the Lab or experiments, and may be directly involved in or impacted by Lab activities. It might be the case that some participants are regularly involved in the ULL's activities while other come into play only in the implementation of the experiments. Any actors who have a significant stake in the Lab and can influence Lab direction should also be included. Having a clear understanding of the actors and how they are involved is critical to the inclusive transdisciplinary nature of Urban Living Labs. The guiding question may be:

- Who are the primary participants (operators, partners, sponsors, etc.) in the lab and experiment activities?
    - What is their level of participation and preferred roles?

2.7.2 Data for answering the questions

Information for this construct will come from the negotiations, plans, and strategies developed by the project partners. It may also come from a system mapping exercise or similar where direct and indirect connections are uncovered.

2.7.3 Potential difficulties

It is possible to not include certain critical participants at the appropriate phase or integrated to the appropriate level, due to an oversight or a misunderstanding of the influence of the particular participant. It is also possible that a critical actor is unwilling to participate.

2.7.4 Example answers

- Core partners of the Lab: Lund University, The Regional Brewers Association, Individual brewing Cos., Swedish Energy (funder).
- Additional actors: Ingredients suppliers, property owners, Systembolaget.

2.7.5 References

- Forrest et al. (2019)

2.8 Background and History

2.8.1 Description of the construct

Each Lab has a story of its beginning. This construct gives space to show the origins of the lab and its initial development. This can situate the experiments in the context of the lab, and provide a base from which to measure how the lab has evolved over time. Guiding questions could be:

- How and when did the lab come to exist?
- Are there any previous initiatives (e.g. partnerships, projects, etc.) that contributed to the development of the lab?

2.8.2 Data for answering the questions

Information for this construct will come from the negotiations, plans, and strategies developed by the project partners. Agreements, documents or previous reports might already exist, providing the necessary information. Additional information can be collected through interviews with key actors.

2.8.3 Potential difficulties

It may be the case that different partners will tell this story differently. This is not necessarily problematic, and could be an interesting aspect that could connect to the future outputs or outcomes. It could, however, be the source of misunderstandings or conflict in the future regarding e.g. the purpose of experiments, or the intended outcomes.

2.7.4 Example answers

- The lab was formed in 2018 from pre-existing partnerships between the main partners and building on existing projects each partner was already involved in.
- The ULL emerged just recently because of the opportunity of a funded project. The existing relationship between specific actors from the university and the municipality facilitated the setting of the lab.
- Preliminary meetings were organized between the partners to design the outline of the ULL since a very first stage of the project, although actors that took part to the first steps of the ULL setting are not necessarily still involved.

2.7.5 References

- Forrest et al. (2019)

3. Manual on the Inputs

Written by Philip Bernert (Leuphana)

3.1 General description on Inputs

Here, we analyze the inputs that are required to conduct the experiments within the Urban Living Labs. The general question that we aim to answer with this section is: *What elements - physical, financial, social, emotional or other - were invested, used, applied, or otherwise put into experiments and other lab activities?*

Within this section we look at five constructs:

1. Awareness
2. Commitment
3. Capacities (Expertise)
4. Trust
5. Support

3.2 Awareness

3.2.1 Description of the construct

Borrowed from Luederitz et al. (2017):

Awareness refers to the ability and consciousness of participants to acknowledge the need for radical real-world changes prior to and during their engagement in the experiment (Bos & Brown, 2012; Nevens & Roorda, 2014). It involves the motives and intentions of participants to participate and helps protect experiments from loss of momentum during later phases (Moore et al., 2005; Wiek, Talwar, O'Shea, & Robinson, 2014).

Guiding question:

What is the general awareness of lab participants of the need for radical real-world changes in line with the lab's purpose?

Further guiding questions identified by the GLOCULL project team are:

- To what extent do actors perceive a need to change (and which actors)/ awareness for change?
- What perceptions do the stakeholders in the ULLs have about the FEW nexus and the ULL ?

3.2.2 Data for answering the question

As suggested by Luederitz et al. (2017): “Typical indicators are sustainability related track records of participants, and participants' general awareness of the sustainability issues tackled by the experiment.”

Data for this section can be collected in various ways. It can be gained through surveys (World Value Survey, etc.) or document analysis (city council decisions) and interviews with project partners.

3.2.3 Potential difficulties

3.2.4 Example Answers

Borrowed from Luederitz et al. (2017):

An illustrative example of awareness as input into a transition experiment is the declaration of the city council to become a carbon neutral city four years before related experiments were initiated in the City of Ghent, Belgium, as reported by Nevens and Roorda (2014).

3.2.5 References

- Luederitz et al. (2017)

3.3 Commitment

3.3.1 Description of the construct

Borrowed from Luederitz et al. (2017):

Commitment refers to willingness, promises, positive attitudes and interests of involved participants to explore “intentionally radical” instead of “incremental or entropic” changes (Karvonen & van Heur, 2014, p. 387). This includes researchers and nonacademic participants' motivation to exceed monetary or reputational benefits and pursue collaboratively taken decisions driven by intrinsic motivations to contribute to a common goal (Ceschin, 2014; Moore et al., 2005). Accountability as a transition experiment output is often dependent on a critical level of initial commitment (as input feature).

GLOCULL Guiding question:

What is the commitment of lab participants to pursue the lab's purpose, fully engage in experiments and complete tasks or activities to the best of their ability, and what is the basis of such commitment (i.e. what is the motivation)?

Further guiding questions identified by the GLOCULL project team are:

- To what extent are different actors committed to the experiment? - What perceptions do the stakeholders in the ULLs have about the FEW nexus and the ULL
- Does the project have a (co) leader, and if so, what kind of person is this (“champion”, commitment)?

3.3.2 Data for answering the question

As suggested by Luederitz et al. (2017): Typical indicators are participants' agreement to deliver tasks on time, participants' engagement in decision-taking, and continuous participation in the experimentation.

Data can be generated in the form of LOIs, agreements, code of conduct, meeting minutes etc..

3.3.3 Potential difficulties

3.3.4 Example Answers

Example from Luederitz et al. (2017): An illustrative example of commitment as input into a transition experiment is the intrinsic interests of participants in the integrated urban water management in Sydney, Australia, reported by (Bos & Brown, 2012). Participants' dedication facilitated a meaningful dialogue between different interests, which resulted in political commitment towards the initiative.

3.3.5 References

- Luederitz et al. (2017)

3.4 Capacities (Expertise)

3.4.1 Description of the construct

Borrowed from Luederitz et al. (2017):

Expertise, including professional skills and experiences, is a critical input for sustainability transition experiments (Wiek, Kay, & Forrest, 2015). It includes recognized professional skills and experiential techniques to research, craft, guide, decide and judge experimentation. Furthermore, it refers to reflexive capacities and abilities to learning from the experiment as well as expertise in issues of ethics, transparency, and power relations (Wittmayer & Schapke, 2014).

GLOCULL Guiding question:

What are the relevant skills, experience, and knowledge of participants with respect to the activities of the lab?

Further guiding questions identified by the GLOCULL project team are:

- What kind of knowledge is used and produced?
- Does the experiment involve participants who possess necessary skills and knowledge to carry out the experiment?

3.4.2 Data for answering the question

As suggested by Luederitz et al. (2017): Typical indicators include related work experience and academic and professional degrees and training of the participants. This data can be collected through document analysis, interviews of participants, etc.

3.4.3 Potential difficulties

3.4.4 Example Answers

Example from Luederitz et al. (2017): An illustrative example of expertise as input into a transition experiment is a participatory technology assessment in Graz, Austria, reported by (Schreuer, Ornetzeder, & Rohracher, 2010). Expertise was provided by professionals from the municipal department for energy, fuel cell development, research institutes and an energy network – critical for designing an experiment on fuel cells.

GLOCULL example

- Different kinds of knowledge are brought together for the clean energy intervention in Lüneburg: knowledge about actors in the local small business sector, knowledge on communication in the local small business sector, knowledge about the design of real-world experiments

3.4.5 References

- Luederitz et al. (2017)

3.5 Trust

3.5.1 Description of the construct

Borrowed from Luederitz et al. (2017): Trust refers to the mutual willingness to collaborate on equal footing, reconcile divergent worldviews, as well as acknowledge different interests (Bernstein et al., 2014; Vandevyvere, Nevens, & 2015). Since experiments are particularly susceptible to failure (Nevens, Frantzeskaki, Gorissen, & Loorbach, 2013), engendering trust amongst participants is important for building participants' confidence in the processes and the potential outcomes of the experiment, making a collaborative experiment and joint addressing of potential difficulties possible. In addition, the process of co-creating knowledge and shared evaluation of the experiments demands trust as a source of open, truthful and collaborative exchange, particularly as interests and reputation are potentially at stake (Trencher, Terada, Yarime, & 2015).

GLOCULL Guiding question:

What degree of trust exists between participants: to what extent are they willing and able to have open, truthful and collaborative exchange, to speak one's mind, and rely on others' judgments and capacities?

Further guiding questions identified by the GLOCULL project team are:

- How are respect, openness, truthfulness and transparency dealt with?
- How are rights, security and safety of participants dealt with?
- To what extent is power equally distributed among actors, and how is this managed?
- Does the experiment involve participants who trust each other?

3.5.2 Data for answering the question

As suggested by Luederitz et al. (2017):

Typical indicators are participants' attitudes toward other participants, ability to speak one's mind, and willingness to rely on others' judgements and capacities. Data for this aspect can be generated through interviews, but also workshop sessions that use gamification

3.5.3 Potential difficulties

3.5.4 Example Answers

Example from Luederitz et al. (2017): An illustrative example of trust as input into a transition experiment is the engagement of university researchers in interventions in Melbourne, Australia, as reported by (Ryan, 2013). The implementation of future exhibitions and tours was welcomed by local councils because they were incorporated into long-term visions and short-term actions proposed by an institution that was seen as independent from commercial developers and the government.

GLOCULL example:

- The Lüneburg intervention on clean energy was co-developed bottom-up by actors and researchers (Master’s students)

3.5.5 References

- Luederitz et al. (2017)

3.6 Support

3.6.1 Description of the construct

Borrowed from Luederitz et al. (2017): Support refers to structural, financial and nonfinancial resources as well as assistance from public and private authorities in preparing and executing sustainability transition experiments (Bos & Brown, 2012; Vandevyvere et al., 2015). It also includes voluntary and in-kind contributions and donation of work beyond normal obligations (Moore et al., 2005; Wiek et al., 2015).

GLOCULL Guiding question:

What support (structural, financial or nonfinancial resources) is available to participants to plan and conduct the experiments or other lab activities, such as funding, staffing, facilities, equipment, endorsements, and to what under what conditions is this support provide (unconditional/full control, in-kind contributions, extension of existing responsibilities, voluntary, etc.)?

Further guiding questions identified by the GLOCULL project team are:

- How much funding is available for the experiment, where does the funding come from and what are requirements for using/ spending funding?
- What is the time frame for funding and how does this time-frame relate to continuation and time horizon of the project?
- What are other resources/ support available, how are they used and who provided for them?

3.6.2 Data for answering the question

As suggested by Luederitz et al. (2017): Typical indicators are available funds, positions, hours of voluntary contributions and endorsements from actors and institutions.

3.6.3 Potential difficulties

3.6.4 Example Answers

Example from Luederitz et al. (2017): An illustrative example of support as input into a transition experiment is reported by (Frantzeskaki, Wittmayer, Loorbach, & 2014). A “Floating Pavilion” was constructed as pilot project for testing social, technological and economic aspects of floating apartments that are. planned for the regeneration of Rotterdam's harbor (the Netherlands). Besides in-kind funding and support by private companies, public authorities and research institutes, the financial investments amounted to € 5.5 million.

GLOCULL example:

- In the case of Lüneburg the funding agency provides a budget for subcontracts to kick-off sustainability innovations

3.6.5 References

- Luederitz et al. (2017)

4. Manual on the Process

Written by Astrid Offermans (MSI)

4.1 General description on Process.

Here we analyze *how* the Living Lab and experiment(s) are completed. Procedures and forms of collaboration are crucial here. The general question that we aim to answer with this section is: What approach(es) and methods are used within the lab and what is the rationale for how this will help achieving the lab's aims? There are five constructs within this section:

1. Experimental procedure
2. Transformational Rationale / Methodology
3. Transdisciplinarity
4. Reflexivity and learning
5. Openness and transparency

4.2 Experimental procedure

4.2.1 Description on the construct

A unique characteristic of a living lab is its experimental character. In the most extreme form, both the process and the end-result are open (i.e. not pre-defined) at the start of an experiment; these are fully co-designed over the course of the project. However, not all experiments adopt a fully open process and the degree to which actions are structured and planned affront varies across living labs.

In this construct, we touch upon the degree of freedom (i.e. lack of pre-defined structures) that exists in producing experimental results. Guiding questions could include:

- To what extent is the experiment formalized?
- To what extent is the outcome of the experiment unclear/ unpredictable? And is the process flexible enough to adapt to unforeseen outcomes? What makes the process flexible?
- To what extent is the experiment independent or nested in a larger or parallel experiment or project?
- What is the rough outline of the project’s planning? How is the experiment structured into a sequence of actions?
- To what extent does the experiment allow for emerging outcomes?
- What is the space for failure?

4.2.2 Data for answering the questions

An experiment is often framed as a project. To invite (potential) partners and attract (potential) funders, a project description or -proposal is often available. What do these reports state about planning? Do they mention deliverables or outputs for specific moments in time, and to what extent is the shape and content of these deliverables already defined and/or delineated in the reports? If reports are not available the project leader, or Living lab contact person may be able to tell you more. The type of data you will use for answering this question is mainly qualitative.

4.2.3 Potential difficulties

We find a lot of variety between a fully organized/ pre-defined process and a fully open, experimental process. It is not always necessary to arrange the process in a fully open way. This depends on the context, including the way in which experiments are embedded in other experiments or projects. When answering these questions, keep in mind that this is not so much about the experiment itself (or the intended outcome), but on the process that enables producing experimental results.

4.2.4 Example answers

- While certain activities are planned and structured, the experiment is managed in a way to allow for reflection, and adaptation, in case new knowledge or unexpected processes require a change of actions, and thus the partners are open to potential emergent outcomes.
- The lab has not formalized its experimental procedure and will develop this while working through a series of experiments. At this point, the thinking is that it will use a general procedure for each experiment along the lines of the following: 1) Initial exploratory discussions with possible participants 2) Agreement on (*co-creation of*) general experiment areas / goals, roles, expectations, commitments, etc. *within the aims and objectives of the accelerator* 3) Baseline assessment(s) suitable to the general experiment areas 4) Detailed co-design of intervention significantly informed by the baseline assessment 5) Design of experimental aspects (e.g. learning objectives, theory of change, variables, measurement, data collection, ...) 6) Implementation of the intervention 7) Data collection / measurement 8) Evaluation and interpretation of results 9) Reflection
- The experiment lab is embedded in a larger project aiming to fully recycle old building material when constructing new houses. The closed adaptive water system will be part of this larger experiment. This means that the process is structured along the same time-line. Experimentation is possible within a demarcated timeline. We start the Living lab with initial ideas on the experiment and with an initial idea on how to further co-design the implementation of the experiment. The process is flexible as follow-up sessions will depend on the outcomes of earlier sessions.

4.2.5 References

- Schäpke et al. (2018)
- Bulkeley et al. (2016)

4.3 Transformational Rationale / Methodology

4.3.1 Description on the construct

The actors involved in a living lab have ideas on what they would like to achieve with the Living lab. This can be a rather abstract aim such as a more sustainable city, or a more concrete aim such as raising awareness on a healthy diet. In all cases, some form of change is needed to evolve from the current situation towards the foreseen situation or aim. At some moment, actors have made the decision that a Living Lab would be a suitable vehicle to achieve the foreseen aims and objectives and to induce the necessary changes. This means the actors involved in a Living Lab have an explicit or implicit idea on the so-called *Theory of Change* underlying the activities in their Living Lab. The Theory of change explains different steps necessary to progress towards achieving the project aim at the end of the project. These steps refer to "in-between-objectives" and the methods and tools used to enable these objectives to be met. Guiding questions include:

- What is the experiment's Theory of Change?
- How does the experiment relate to (changes in) the FWE-nexus?
- How do the different steps in the experiment relate to each other and how do they lead to the foreseen/ desired results?
- What methods and tools are used in the living lab? Why?

4.3.2 Data for answering the questions

Where the ultimate aim of the experiment can often be expressed in quantitative terms (e.g. 20% reduction in energy use; 100% circular use of water), this is much more difficult for the Theory of Change. The Theory of change explains different steps necessary to progress towards achieving the project aim at the end of the project. These steps refer to "in-between-objectives" and the methods and tools used to enable these objectives to be met. This information, particularly on the steps and tools, can be found in project proposals or project-plans. It is not always clear or transparent how the different steps in the process relate to each other and to achieving the overall aim. It is good to discuss this with the living lab participants if it is not explicitly referred to in project plans.

4.3.3 Potential difficulties

The more open and experimental the character of your process (see previous construct), the more difficult it will be to answer the question underlying this construct. If the process is highly structured (see previous construct), it will be relatively easier to answer this question. Having said this, it is not impossible to answer this question if you have a highly experimental and open process in place. In those cases it may help to start thinking from what you consider to be a crucial element in your living lab and experimentation process. These can be aspects such as 'Public perception", "capacity building", "sustainability certification" etcetera. In a next step you explain why these concepts are crucial to your living lab and how they ultimately need to be covered to achieve the lab's aims. Further, it is not always clear or transparent to the Lab participants how individual meetings and steps relate to each other and the ultimate goal/ aim. To strengthen the Experiment's Theory of Change, we encourage Living Lab participants to discuss these issues, which also helps answering this question. Finally, you may phrase the methods and tools as specific as you want. Methods are demarcated approaches for a scientific investigation, or a channel to (co)produce knowledge. Within every method several concrete tools may be used to gain the necessary knowledge and insights. Stakeholder participation or dialogue may be a method, whereas focus group discussions and World Café sessions can be considered tools.

4.3.4 Example answers

The overall approach of the lab is to conduct a series of experiments to learn about how to effectively build capacity among local food actors to develop sustainable enterprises and economy solutions, and to institutionalize the lessons learned in a sustainable local food economy accelerator.
The rationale is that (1) by building capacity of entrepreneurs and businesses, new businesses will be

formed or existing business changed to adopt more sustainable practices, and connections will be created or strengthened that support and increase the sustainability of other enterprises; (2) by creating an accelerator, the knowledge, skills, and resources needed to deliver capacity building services to entrepreneurs and businesses is strategically concentrated and coordinated in a way to maximize effectiveness; (3) by institutionalizing the accelerator, it continues to build the sustainable local food economy after the lab ends towards significant (transformational) levels; (4) by building broad-based sustainability capacity in businesses, sustainable FWE practices will be realized in the long-run, if not as an immediate objective of experiments.

The lab draws upon existing research, extensive knowledge of lab partners, and specific input from other stakeholders, to identify gaps, opportunities and intervention points in the sustainable local food economy (pragmatic transformational sustainability research). Experiments engage lab partners and local food actors in co-design and execution (participatory design).

4.3.5 References

- Luederitz et al. (2017)
- Taplin and Clark (2012)

4.4 Transdisciplinarity

4.4.1 Description on the construct

One characterizing element of Living Labs is their transdisciplinary approach. This refers not only to the involvement of actors from different domains (e.g. science, public administration, civil society, businesses), but also to the way in which they interact and co-create knowledge and solutions. The need for bringing social actors / stakeholders *into* the research process is dictated by the complex nature of sustainability problems. Scientific knowledge will not always suffice for *understanding* the different components of the problem and the different ways in which potential solutions may affect the problem and the behavior/ values/ networks of actors involved. For this, practical/ embodied knowledge is necessary. Further, involvement of actors in the research process is needed to acknowledge the normative nature of sustainability problems, solutions and ideals. This includes value plurality (i.e. the existence of different perspectives/ frames/ worldviews), ambiguity, controversies (e.g. regarding different interests) and uncertainties. Guiding questions include:

- How and by whom are research questions formulated?
- How does the experiment foster collaboration?
- Who has the lead in the project and what (kind of) organization does this person represent?
- How and by whom are solutions formulated?
- How and by whom is the process designed/ the work plan formulated?
- How and to what extent are different participants involved?
- Does the project have a (co) leader? What kind of person is this? Are his/ her roles clear? If so, who defined this role?
- What actors have an influential position and what makes their position influential?
- To what extent are the results relevant for actors from different domains?

4.4.2 Data for answering the questions

Data underlying this construct is hard to gain from a position external to the Living Lab. It refers to information that can be gained through participation in the lab's activities. Formalized roles and responsibilities may also be specified in an experiment's work plan, but the description on paper does not necessarily coincide with the situation in practice.

4.4.3 Potential difficulties

TDR does not provide a static blueprint for doing science with society. It may also happen that, in some stages of the research, researchers are working within one academic discipline to - only in a later stage- feeding the acquired knowledge back into the wider TDR process. TDR implies a continuous and dynamic interchange between theory and praxis. Answers to this question may therefore change on a regular basis during the lifetime of a Living Lab and experiment.

Sometimes it is also difficult to understand the full extent of what 'knowledge' may comprise of. This is because different kinds of knowledge can be coproduced. In the scientific literature we see reference to "*systems knowledge*" that describes knowledge of the systemic nature of the current state (i.e. the situation as it 'is' or appears to 'be'). "T*arget knowledge*" describes a possible future situation that may be more or less desirable, just or sustainable (the situation as it 'ought to be'). "Transformation knowledge" is a strategic type of knowledge aimed at discovering the evolutionary potential of the present – co-designing and figuring out what are the plausible next steps *in the direction of* the more desirable situation, and *away from* the undesirable situation. All knowledge types, but in particular the Target knowledge is very normative. People may hold different interpretations on the situation as it ought to be, and the extent to which a desired future state deviates from the current situation. It is good to make these different interpretations explicit in your Living Lab.

4.4.4 Example answers

Due to historical development of the project, and the knowledge, capacity and resources of the main partners, ASU has taken the lead in forming the lab, setting the direction, and managing work. For example, ASU: forms and documents rationale and conceptual framework; defines the work plan; calls and schedules meetings sets agenda; hosts meetings at their location and facilitates meetings; defines methods and data collection structures. Decisions are made by all partners in plenary meetings but always led by ASU (what is the decision to be made, how is it framed, how will it be made).
In selecting experiments to conduct, there has been an attempt to adopt a somewhat objective process based on collecting standardized information on possible experiments and using a set of criteria to evaluate them, yet the criteria and information to be collected were largely defined by ASU. While these have communicated and discussed and adapted, other partners have not had the time and fuller knowledge needed to really make a meaningful contribution to the development of criteria and decision making procedures and so forth. As such, experiment selection may reflect ASU's interests more than others.

At the experiment level, participants (i.e. businesses, entrepreneurs) will be invited and encouraged to participate in defining experiment goals and objectives, designing experiment details, implementing experiment work tasks (e.g. making physical or organizational changes), and measuring / collecting data.

Some of these tasks will be impossible without a high degree of involvement from the business participants.

4.4.5 References

- Lang et al. (2012)
- Funtowicz and Ravetz (1993)
- Offermans and Kemp (2016)

4.5 Reflexivity and learning

4.5.1 Description on the construct

Learning – often in combination with experimenting – is a key activity in Living Labs, because a major goal is to learn about new ways of doing and responding to problems. In ULLs, learning does not only concern the technical and economic aspects of an innovation, but also the social, cultural and institutional implications. This implies that learning is a specific target in Living Labs, and it is not "just" seen as a side-effect of the Living lab activities. As learning is specifically targeted at, the learning process in Living Labs needs to be supported/ managed, for example via the development of a joint learning agenda (a short list of learning goals or questions) and repeated collective reflection on the experiences with the experiment, which may lead to the formulation of new learning questions. Guiding questions:

- What is the approach towards learning and to what extent is this approach shared by the different participants?
- How is learning stimulated and by whom?
- How are actions, structures, processes and outputs analyzed and evaluated?
- Is there a shared learning agenda? Who developed it and who monitors it?
- Are there specific events/ possibilities created for reflection?
- Are there procedures in place in which learning and reflection may be fed back into the experiment (i.e. cause the experiment to be changed/ adapted to new insights)?

4.5.2 Data for answering the questions

As Learning is targeted at in Living Labs, one would expect a document in which learning goals or a learning agenda are presented and shared among the living lab participants. Participation in a living lab also offers information on the way in which the participants deal with emerging and/ or unintended outcomes and the extent to which attention is paid to learning throughout the process. Further, if events are announced, it can be analyzed whether learning is mentioned as an explicit outcome of the event.

4.5.3 Potential difficulties

There are different ways in which people learn and also the content of the learnt information can be very diverse. In ULLs, learning does not only concern the technical and economic aspects of an experiment, but also the social, cultural and institutional implications. Learning is a process of acquiring new, or modifying existing, knowledge, skills or attitudes. This may lead to behavioral change, but this is not necessarily included in the definition of learning. The sources of learning can also be diverse and vary from (new) information provided to participants to interactions among participants.

4.5.4 Example answers

- Reflection and learning are not formally defined within the lab. However: a primary objective of the lab to learn about how to effectively build capacity for advancing the sustainable local food economy. Lab activities, including experimental procedures, have not been rigidly defined at the start, but are being developed over time; it is intended that reflection on activities will take place at multiple times and will be used to adapt methods / procedures moving forward.
- Learning has been central and shared e.g. during CLD modeling and Flow Diagramming - these examples serve to generalize as we get more familiar with each other's (partners) roles, interests, background, and expertise. There is no learning agenda outside of the experiment's purposes. The experiment is highly adaptable within parameters.

4.5.5 References

- Luederitz et al. (2017)
- Forrest and Wiek (2014)
- Evans and Karvonen (2014)
- Van Mierlo and Beers (2015)

4.6 Openness and transparency

4.6.1 Description on the construct

Transparency refers to openness in what an organization does. This implies open communication about things that go well and things that do not go well. One condition of transparency is making relevant information, including knowledge, publicly available (see van Straalen 2018). Different roles, responsibilities, power dynamics and positions may create unequal ways in knowledge distribution or access to knowledge. To avoid marginalization and exclusion of actors, procedures should be in place to guarantee knowledge sharing and truthfulness.

- Who decides on what knowledge can be considered relevant and how?
- How is information made available to participants? Do all participants receive the same information (in terms of content and quantity), if not, why is this the case and who decides on what information is shared with whom?
- Is the way in which information is presented relevant and accessible to all actors?
- If different participants receive different forms of participation, how is marginalization and exclusion prevented?
- Is there an approach towards protection of knowledge? Is this approach equal for all participants?
- Does the experiment result in sensitive knowledge, or knowledge that may be patented?
- To what extent do participants differ in the extent of knowledge they can bring into the experiment? Does this create any power imbalances?

4.6.2 Data for answering the questions

One may analyze whether there are any information sharing platforms in place, and whether these are accessible to everybody. Pay attention to the reading and editing rights of the different participants. Are meeting notes prepared and approved and by whom? Observation and participation in a Living Lab may also help to gain data for answering this question. Be aware that marginalization and exclusion (on the basis of unequal access to information) are not always easy to recognize. If documents and observation give reasons to believe in an unequal distribution of information, it may be worthwhile to talk in person to different participants in the Lab. Goals of these talks may be to see how the participants perceive the transparency and distribution of information.

4.6.3 Potential difficulties

This question touches upon the availability and transparency of information. Information in the context of a living lab is broad and may cover details on the process or structure of the Lab, data, decisions made (including decision making procedures) and results of the experiments and lab activities. It is possible that transparency is high in some of these factors, and low on others. You can indicate these differences under this construct. It is also possible that knowledge and information sharing differ intensively during the life-time of the experiment. There may also be good reasons to not directly spread all information to all Living Lab actors. Important however is that all actors should receive sufficient information to contribute to the Living Lab's activities in a meaningful way.

4.6.4 Example answers

- The researchers and practitioners are learning directly from the experiments and the data, and sharing the data collected with the rest of the group, as well as explaining and discussing together what it means. After the first data is collected, more joint meetings will be organized in order to facilitate co-learning. Also more public events and discussions will be organized. Joint reflection and evaluation will also take place.

- Meetings and workshops that occur in the ULL and experiment are spaces for constant reflexivity and learning. In these occasions, it is possible to discuss if adjustments are needed based on what is working and what is not. There is little space for failure. The participants are not keen to take risks and the initiatives tend to aim at objectives that do not result in great losses if not achieved.

- Project documents, including concept notes, meeting minutes, presentations, collected data and so forth, are generally shared by email to all partners. Additionally, a shared Dropbox folder is used store project documents, though this can sometimes be troublesome to access and may not always be easy to find specific documents or documents may not be up to date.

4.6.5 References

- Luederitz et al. (2017)

- Evans and Karvonen (2014)
- Ryan (2013)

5. Manual on the Outputs

Written by Amanda Gcanga (SUN)

5.1 General description on the process

Outputs in an experiment are described as real-world changes generated that contribute towards desired outcomes. This manual investigates five types of results that can be generated in an experiment. They are capacity that has been built, knowledge, accountability and commitment, physical structure, social structures, and the uptake of experiments. Generated outputs might lead or initiate new processes, investments or resources to carry forward the experimentation.

The rest of this section provides a brief description of each of the outputs mentioned above.

5.2 Capacity

5.2.1 Description of the construct

Built capacity looks at the extent to which a lab experiments capacitates participants to act sustainably in everyday decision-making and practices through education, practical and interpersonal competencies, and activating new behavioural patterns. Ultimately, it the ability of participants to apply results from an experiment.

Capacity built in an experiment includes strategic competence, practical skills for developing partnerships and ability to develop long-term sustainability plan. These capacities are built throughout the experimentation in a planned and unplanned way. A key evaluative question that would be asked would be looking at whether the transition experiment-built capacities in participants to generate sustainability solutions. Additional questions could be:

- What type of capacity is built in participants through the experiment?
    - Soft skills (establishing or expansion of a network that aims to act sustainable, strategic competence, ability to communicate sustainable solutions, incorporating sustainability thinking in every-day practices)
    - Technical (skills to launch and run sustainable business, acquiring new technical language and skills)
- What post-experiment activities do participants engage in and how do they carry out sustainable practices?

5.2.2 Data for answering questions

Data for answering the guiding questions involves an in-depth understanding of changes that have taken place with participants as a result of the experiment. These may be in terms of the skills and abilities that they have acquired at the end of the experiment. A range of skills abilities include designing and implementing strategic and long-term interventions, ability to collaborate and partner, having a systematic view, and being able to anticipate changes. At the start of the experiment, it is crucial to note the capacities that participants bring to the table and what they lack. Along the implementation of the process, observations and team reflections can assist in spotting whether there are different sets of capacities generated. strategic and long-term interventions for sustainable solutions.

Continues feedback and learning sessions with the team might be critical in understanding capacity generated during and at the end of the experiment.

Post -experiment activities also provide an opportunity to spot built capacities. One would have to analyse changes around capabilities of participants to organise networks and coordinate implementation of experiment results.

5.2.3 Potential difficulties

It might be challenging noting acquired skills post experiment activities. The pace at which post-experiment activities take place might not be ideal.

5.2.4 Examples of answers

- There is learning taking place within the experiment. A participant that initially had limited understanding of energy systems has acquired skills and the ability to monitor energy produced by panels and adjusting his energy use accordingly. We envision that as the experiment continues more learning about acting sustainably takes place.
- Craft beer breweries are inherently motivated toward efficient resource use. However, the experiment brings about a habit of generating new ideas of more sustainable practices and the need to generate evidence.
- The primary purpose of the experiment is to capacitate participants (entrepreneurs, business owners, workforce) for sustainable business development and to transfer and scale sustainable business practices.

5.2.5 References

5.3 Knowledge

5.3.1 Description of the construct

The construct of knowledge is concerned with understanding the extent to which a lab experiments can generate evidence-supported (tested) instructions for effectively solving a sustainability problem within the defined experimental setting. The knowledge produced from an experiment should actively guide the process of moving from the current state to the desired one. This may include guidelines on how to reach most effectively transition from the current to the desired state. Knowledge generated in an experiment can be analytical-descriptive, anticipatory and normative, and transformative. In addition, knowledge generated can be scientific and practical.   Guiding questions may include:

- What kind of knowledge is used and produced?

- What scientific insights are expected to be gained in the experiment?
- What practical insights can be produced?

5.3.2 Data for answering questions

The nature of labs often involves participants from different sectors such as academia, civil society and private sector. As stated above, there are different types of knowledge that can be produced as outputs in a lab. For scientific knowledge, it would be expected that the scientific team, scientific journal articles and book would indicate such kind of knowledge. In some experiments, scientific knowledge can be co-developed with non-scientific participants through transdisciplinary research approaches. Practical knowledge on the other hand can be co-produced by all participants involved in the lab. Practical knowledge outputs may include a guide, tools, and a framework on how to implement sustainable experiments or transitions. Training is also an important way method to generate practical knowledge.

5.3.3 Potential difficulties

Because a lab entails participants from different sectors, it might be a challenge to integrate the different knowledge systems that exist within one experiment. This may give a rise to questions such as what knowledge system gets used in the design process of the lab. In addition, ensuring that one knowledge system does not overpower others might be a challenge. In cases where the are strong academic participants, there is a danger of prioritising academic knowledge and as a result losing interest of the participants.

5.3.4 Examples of answers

- The knowledge generated is packaged in the form of procedures, tools, materials, training programs, networks, information, models, and such like that can be used in multiple ways to support sustainability capacity building in other enterprises.
- The experiment will provide technical know-how for placing PV panels on a greenhouse and maintaining them. This could be used in replicating or upscaling the experiment
- The experiment aims to produce systems knowledge which is concerned with interrelations of food and energy, and other sectors, understanding of the FWE system

5.3.5 References

5.4 Accountability and Commitment

5.4.1 Description of the construct

The output of accountability and commitment is concerned with the extent to which experiments ensure confidence and commitment of participants to implement results generated by the experiment and their dedication to positive change. The commitment as an output can be packed in various ways, formal or informal, depending on the nature of the relationship between the partners. This can be in a formal or informal way such as an MoU, ToR and mandate with clear items for action. Informal commitments include change attitudes and behaviour of the participants. A collaborate process is developing a formal commitment. This way, each participant is comfortable with the role they are committing to in the implementation of the results. Collaborative process also ensures that there is ownership of the next steps to unfold. Questions that may guide this construct are as follows:

- Are participants motivated to take part in the implementation of experiment results?
- How does the experiment build confidence in participants to generate and realise sustainable solutions?
- How does the experiment build commitment within participants for reaching sustainable solutions?

5.4.2 Data for answering questions

Accountability and commitment should provide an indication of how much participants are willing to the on-going and future processes. Informally, the behaviour and attitude of participants provides an indication of commitment. Formal agreements as well also point to the level of eagerness for participants to participate in the implementation of generated results.

5.4.3 Potential difficulties

It might be challenging to study people's behaviours as a measure for willingness to continue with suitable activities. An added later of difficulty might be understanding causes for lack of commitment which might include a sense of unfairness amongst the participants in terms of the agreements for future steps. An outsider or intermediary part might be required to facilitate this process of ensuring commitment of participants.

5.4.4 Example answers

- Participants provide feedback and receive encouragement during the experiment. After the experiment they can receive ongoing support and are obliged to provide periodic updates on their progress.
- There is the expectation that activities within an experiment that are conducted through a participatory perspective will improve levels of commitment and accountability towards sustainable and positive changes.

5.4.5 References

5.5 Physical structures

5.5.1 Description of the Construct

The physical construct aims to understand the extent to which experiments create new or transform existing buildings, infrastructures, technologies and products that are radically different from existing ones. The different infrastructure may include sustainable buildings, green infrastructure, innovate energy systems and new vehicles. Real change in physical structures often comes with a new sense of seeing the function of the structure, the relationship between humans and the structure as well as new priorities. A guiding question to unpack this construct one would have to look at how the experiment generates physical changes that support solutions for the identified sustainability problem. additional questions may include:

- What is the change in a physical structure that emerged out of the experiment?
- Did the change emerge from reforming existing infrastructure or totally new?

5.5.2 Data for answering the question

At the start of the experiment, the setting provides a basis as well as the nature of the experiment. At this point the participants agree on the focus of the experiment. In a case where the focus is physical structures, the experiment should have detailed description of the differences between new infrastructure compared to existing ones. The description should entail how the reformed or radical physical structure is a more sustainable solution. Participants would need to agree on whether the new physical structure is totally new or modified. If modified, participants would need to have a grasp of the level of the changes. Based on the agreed use of the physical structure, participants would also have to address concerns around commercialization, production, manufacturing, integration of the technology into existing systems and the scale of the desired up-take.

5.5.3 Potential challenges

An experiment where a radical change in a physical structure is an output, there might be a challenge with the level of changes or radicalness to be achieved. This is attributed to fact that different participant in an experiment understand the use of the physical structure differently. In addition, participants might their have priorities, behaviour and disagree on the appropriate level of sustainable change desired. It can be difficult to reach a common agreement around transformation of the physical structure of participants in an experiment do not agree on the above-mentioned factors. Bring the experiment to real life might also pose challenges. These may include patent and production.

5.5.4 Example of answers

The experiment transforms greenhouses, via experimental installation of PV panels of different types on them.

5.5.5 References

5.6 Social structures

5.6.1 Description of the construct

Some experiments are not concerned with physical structures but rather the social structures. This construct is concerned with the extent to which experiments create new or transform existing networks and organizations, values and norms, rules and policies, behaviour and practices, decision-making processes, and discourses that are radically different from existing ones. A change is social structures may result in new or altered activities, practices, policies and social relationships. The outputs on social structures are concerned with aim to understand how experiments generate societal changes that support solutions for identified sustainability problems. The following questions might assist in unpacking this construct:

- What kind of social change emerged?
- What societal structure/s were changed?
- What difference was made to bring about social change?
- At what societal level the social change take place?
- In what context does the social change generated?

5.6.2 Data for answering questions

Social behaviours provide an opportunity to understand changes in social structures. These may include new or altered behaviour, new ways of relating, change in practices and routines, and establishment of new relationships. One may also analyse the whether there has been an establishment of networks and forums that are radically different from traditional ones and bring about more sustainable activities.

5.6.3 Challenges

Societal structures are interconnected, and it may be challenging to analyse and measure social change. Additionally, it is more challenging to attribute change in social structures purely to the experiment.

5.6.4 Example of answers

- There is a potential foster a network of sustainable craft beer brewers through a development of a website with information around sustainable practices and lessons. This has the potential to shift mindset and ultimate change practices.

- Connected stakeholders to form new networks, and assisted participants to form a new business entity that foster sustainable practices.

5.6.5 References

5.7 Uptake

5.7.1 Description of the construct

The uptake output aim to understand the extent experiments create generalizable lessons about how to achieve similar outputs and outcomes in different contexts or that facilitates the uptake of experiment results at larger scales. The intention of setting up an experiment is ideally to facilitate the take-up of the transition. Generally, the uptake output is concerned to understand whether the experiment can be replicated elsewhere and the conditions for replication. In addition, one would look at scalability of the experiment in terms of expanding the experiment and the facilitation needs. Guiding questions to explore this construct include the following:

- How does the experiment connect different geographical locations and sectors?
- How and to what extent does the experiment connect local and global scales?
- Does the experiment indicate how it can be transferred to different contexts or higher hierarchical levels?
- Does the experiment account for unintended consequences that are associated with the sustainability solution?

5.7.2 Data for answering questions

To analyse transferability of the experiment, one would have to conceptually explore comparative, feasibility and case studies. Important aspects to look out for would be similar indicators and validity of cause and effect.

To analyse scalability of the experiment, scalable properties would have to be evaluated through feasibility studies. An important aspect to consider in feasibility studies would be the governance systems and integration of systems in targeted areas. In addition, participatory approaches such as engagement with actors that operate in areas that are earmarked for scaling up would be necessary.

5.7.3 Challenges

There are numerous challenges around understanding how the different contexts might enable to hamper an experiment ranging to the methodologies for feasibility and comparative studies, but also the methods for engagement with actors that operate in targeted areas and transfer of knowledge. Other challenges include factors such as human behaver, attitudes, which one cannot really know until a result of the experiment is being generated.

5.7.4 Answers to questions

- Experiment includes an explicit step to generalize lessons learned and to make the knowledge useful for facilitating up-take such as identification of key success factors within a contextual framework, to perform extrapolation exercises, and conduct systemic effects thought experiments
- There are many advantages to local hop growing under controlled conditions, especially as climate change makes traditional hop growing locations less reliable in terms of quality and characteristics. This method is being viable although this is happening at a slow pace.
- There is potential to transfer the experiment to local similar contexts

5.7.5 References

6. Manual on the Outcomes

Written by Nigel Forrest (ASU) and Astrid Offermans (MSI)

6.1.1 General description on Outcomes.

In this section we analyze the impact of the Living Lab and/or the experiment(s) conducted on comprehensive sustainability outcomes. We use six broad impact constructs, derived from Gibson's (2006) sustainability assessment criteria, broken down into sets of more detailed analytical categories (sub-criteria) to describe the changes resulting from the lab's activities. At this level, analyses are somewhat comparable between living labs, or between experiments. However, the exact nature of outcomes within each analytical category will differ depending on the experiment, lab and overall context. The analysis of impacts within each category, then, is based on the change observed in one or more indicators, and these indicators may be different from lab to lab.

All of the criteria may / should be considered at multiple spatial scales (urban/metro area, region, national, global), system levels (e.g. multi-level governance, local, national and global economies), and timeframes (present, near-term and long-term future), and not only at the most immediate ULL impacts. For example, in food systems, the activities within the ULL may have impacts on distant as well as local ecosystems and livelihoods.

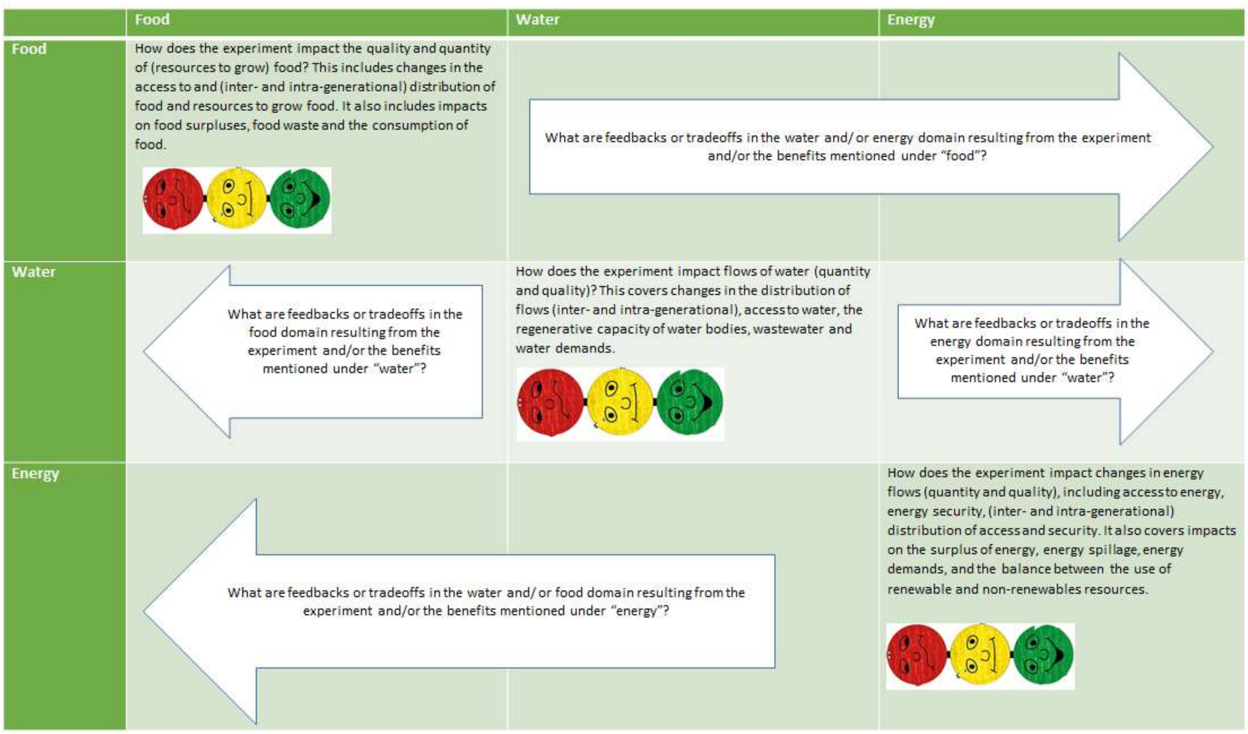
6.1.2 Specific description on food-water-energy Outcomes.

The scheme below can be used as a guideline to investigate an experiment's outcomes on the food-water-energy nexus. In a **first step**, we look at the three domains in isolation. What are the experiment's impacts (both in terms of quantity and quality) on food, water and energy flows? This also covers discussions on the (equal) distribution of flows, access to flows, the availability of surplus, amounts of waste and spillages, changes in demands and the regenerative capacity of resource stocks.

In a **second step**, these impacts are evaluated for the isolated domains. Living lab particpants can use a traffic light system for this evaluation, where green stands for positive impacts, orange for no, or a neutral impact, and red for a negative impact. This evaluation is not a straightforward process. When can something be considered to have a negative impact and when is the impact positive or neutral? This is not only a rather subjective and therewith personal judgement, it also strongly depends on the context at stake. A flood-prone area for example, may evaluate a decrease in the quantity of water flows as a positive outcome, whereas dry regions will most likely judge differently. Also, an impact in the distribution of flows can not univocally be evaluated: maybe a change in the distribution leads to less water or energy for some groups or some generations, but simultaneously guarantees a more equal distribution overall. Our advice is to jointly discuss the impacts and ways in which they can be evaluated with the participants of the living lab.

In a **third step**, the three different traffic lights will be discussed. In the most ideal situation, all three lights present a green light. A minimum requirement would be to have at least 1 green light and no red light. If this minimum cannot be achieved, it is important to jointly redesign the experiment in such a way that positive impacts in 1 or 2 domains do not go at cost of any other domain.

If this is guaranteed, one may start with the **fourth step**. In this step, the experiment's impact on the nexus is further explored. It is important to discuss and explore whether interconnections across food, water and/or energy create any tradeoffs or feedbacks. Do positive impacts in one domain feedback into negative impacts in any other domain or vice versa[4]? When discussing feedbacks and potential tradeoffs, it is important to also discuss the time and scale under analysis (see next section).



6.2 Potential difficulties in analyzing outcomes

Measuring and evaluating outcomes is not a precise process and is often more subjective than objective. There are some common problems in analyzing all of the outcomes.

- ***Timing.*** Identifying and evaluating outcomes depends upon the timing involved. Early in the lab activities and experiments there will be few, perhaps no, outcomes. In some cases, outcomes may not manifest themselves until years after the intervention is complete. It may therefore be sometimes necessary to anticipate outcomes and/or look for signs that progress is being made towards ultimate outcomes, i.e. identify intermediate outcomes.

- ***Scale.*** The impact of lab activities on outcomes can vary greatly depending on the scale being considered. Often the activities are small scale and focused on a particular unit of analysis and a

[4] Schünemann (2018) provides a telling illustration on feedbacks for the case of biofuel production in Malawi. She illustrates that a change from subsistence food crop farming to farming crops for biofuel production initially leads to a decrease in food security. However, over time, investments in biofuel crops seem to increase labor opportunities and income, therewith impacting rural development and poverty and (indirectly) improving food security again.

selected group of participants. For example, at the household level in a particular multi-unit building, or at the business level with a set of selected small enterprises. Outcomes at the experimental level may be very significant but negligible when viewed at larger scales, such as the city, national, or global. For example, the experiment may generate 50% reductions in water and energy use by the participating units but this is of zero measurable impact on total city water supply or on global greenhouse gas emissions. To avoid getting entangled in such scaling difficulties, the approach to take is to limit analysis of outcomes to the experimental setup, and to conduct a separate scaling study to consider the impacts of scaling the experimental results up to larger scales. However, the analysis should include identification of possible impacts at different scales without any attempt to quantify them.

- ***Attribution.*** Urban living labs are open systems and outcomes are often influenced by many endogenous factors. It is therefore often not possible to attribute outcomes solely to lab experiments and activities. Outcomes are a result of the outputs of lab experiments and other activities. Each identified output may map to zero or more outcomes. Thus, there may be a complex set of connections between outputs and outcomes. In some cases the connection, or causal pathway, is straightforward, for example, the implementation of energy efficiency upgrades to a brewery reduces energy demand and greenhouse gas emissions, both of which improve the resource efficiency and maintenance outcome (the energy source and the climate both being resources), as well as other possible outcomes. In others, the pathway from outputs to outcomes will be more complex. For example, building the capacity of peri-urban farmers to switch to organic production (an output) may eventually lead to increased sales and consumption of organic vegetables in the urban area (an intermediate outcome) and impacts in multiple outcomes, including Socio-ecological Integrity and Livelihood Sufficiency and Economic Opportunity. But many other interventions would be necessary to make this happen, some of which might be other outputs of the lab and others which might be outside the lab's activities. In doing a thorough analysis of outcomes, it would be important to identify and explain causal pathways from each output to outcomes, as well as to identify other possible factors that may have enabled or inhibited the outcome.

6.2.1 References

The articles below provide some further guidance and insight into analyzing sustainability outcomes, by both general discussion and some as examples of analysis. The article apply to all of the sustainability outcomes we use, although the exact set of outcomes varies in the articles.

Articles describing outcomes and / or providing guidance on their analysis:

- Gibson (2006)
- Luederitz et al. (2017)
- Wiek and Forrest (2017)

Articles providing examples of sustainability outcomes analysis:

- Larson, Wiek, and Withycombe Keeler (2013)
- Kuzdas et al. (2016)
- Forrest and Wiek (2014)

6.3 Socio-ecological Integrity

6.3.1 Description on the construct

The concept of socio-ecological integrity refers to the interdependence of human well-being and biophysical conditions and, for the goal of sustainability, the necessity of protecting, regenerating, and enhancing ecological systems and integrating them with human activities to establish stable, harmonic, integrated relationships. With regards to FEW, socio-ecological integrity in urban areas may include green infrastructure developments such as urban forests, conversion of vacant brownfield land into sustainable farms, or the restoration of urban rivers and wetlands. Activities within the ULL can also have impacts on regional and distant ecosystems. For example, food businesses in the urban area may preferentially source from regional or global farmers and support them to farm sustainably and regenerate their respective local ecosystems. Example questions that could be answered here include:

- How does the experiment influence the way in which agriculture is organized (including labor issues and ecosystem services)?
- How does the experiment influence water flows (quantities, quality and regenerative capacity)?
- How does the experiment influence flows and sources for energy (renewable and non-renewable)?

6.3.2 Data for answering the questions

Examples of indicators that may be used include:

- Environmental flows of local or regional rivers
- Environmental quality of local or regional rivers
- Urban forest cover
- Marker species abundance (e.g. pollinators)
- Area being farmed sustainably
- Consumption of sustainably farmed food

6.3.3 Potential difficulties

See general issues in analyzing outcomes.

6.3.4 Example answers

Examples from two living labs in early stages are given, the first a sustainable food economy and enterprise living lab, and the second a sustainable apartment building living lab.

- More enterprises adopt some operational practices that do not damage or that regenerate the environment. Existing enterprises adopt more environmental sustainable operational practices and push these practices further. Scope and nature of such practices may include:
  - Supply chain sourcing of organically / sustainably farmed ingredients
  - Locally sourcing ingredients / products

  - Switching to lower water use ingredients
  - Internal process efficiencies (see also productivity)
  - Utilizing local renewable sources of energy and water (e.g. onsite renewable energy generation, onsite rainwater capture)
  - Engaging in system-wide schemes to ensure reduced water / energy input results in environmental benefits

- The innovation may lead to a more efficient use of water which may benefit the surrounding environment in times of droughts and peak rainfall periods. Waste water is treated locally and reused for different purposes. Also energy will be more efficiently used as heat from shower waste water may be reused and the waste from the vacuum toilets and food grinders will be used to create biogas and resources for agriculture. It is not sufficiently clear what the demand for agricultural resources will be, both locally and beyond a local scale. In the Netherlands, there is an excess of nitrogen. As a consequence, there are strict regulations on the use of fertilizers and agricultural resources. Finally, by using vacuum toilets, the water use per toilet visit will be much lower compared to a normal toilet (i.e. 1.0-1.5 liters of water compared to 6-8 liters).

6.3.5 References

Articles describing outcomes and / or providing guidance on their analysis:

- Gibson (2006)
- Luederitz et al. (2017)
- Wiek and Forrest (2017)

Articles providing examples of sustainability outcomes analysis:

- Larson et al. (2013)
- Kuzdas et al. (2016)
- Forrest and Wiek (2014)

6.4 Livelihood Sufficiency and Economic Opportunity

6.4.1 Description on the construct

This construct refers to the ability of people to provide basic and enhanced needs for themselves and their families through decent work, and to have access to opportunities for economic development. Basic needs include water, food, housing, energy, education, healthcare, safety and security, whereas enhanced needs include broader social, leisure, and creative activities and so forth. Opportunities for economic development allow people to engage in enterprising activities that can generate surpluses and build community wealth.

With respect to food, water and energy, having a positive impact on this construct means not only access to these resources for basic consumption purposes, but that the production and use of these resources is done in ways that empowers people and communities to do much more for themselves than meet basic survival needs. Example questions that may be answered include:

- How does the experiment influence access to food, water and energy?
- How does the experiment influence (access to) resources necessary to grow food?
- To what extent does the experiment change (the existence of) surpluses in food, water or energy?

6.4.2 Data for answering the questions

Examples of indicators that may be used include:

- Access to clean water
- Access to energy
- The prevalence of food deserts
- Unemployment rate
- Poverty rates
- Quality of jobs
- Locally owned businesses

6.4.3 Potential difficulties

See general issues in analyzing outcomes.

6.4.4 Example answers

Examples from two living labs in early stages are given, the first a sustainable brewing living lab, and the second a sustainable food economy and enterprise living lab.

- The actor groups involved in the craft beer world are generally middle class. Craft beer is an element and example of the quality of life people in this class group choose. In that sense, this experiment is an example of how they can exercise their power and capabilities to advocate for a more sustainable value system embedded in their consumption habits. Hop experiment or principles?
- Enterprises are created or adapted to support subsistence activities, such as growing food, cooking or producing food, or exchanging food or ingredients or other materials for direct individual, family or community use.

6.4.5 References

Articles describing outcomes and / or providing guidance on their analysis:

- Gibson (2006)
- Luederitz et al. (2017)
- Wiek and Forrest (2017)

Articles providing examples of sustainability outcomes analysis:

- Larson et al. (2013)

- Kuzdas et al. (2016)
- Forrest and Wiek (2014)

6.5 Intra- and intergenerational equity

6.5.1 Description on the construct

This construct reflects the degree to which the benefits and risks of food-water-energy consumption and production activities are justly distributed and result in inequalities. This includes consideration of inequality across people within the ULL region, and with people in other regions. It also includes consideration of whether current activities will allow future generations to have at least the same opportunities to live decent lives. While Livelihood Sufficiency and Economic Opportunity (above) considers whether food, water and energy resource supply and associated activities is sufficient (to meet needs), this construct looks at distribution of impacts (positive and negative) within and across communities, both today, and in the future. Inequitable distribution may be simply due to spatial implementation boundaries, but there may also be clear socio-economic factors and underlying and more subtle issues of racial, religious, political, discrimination at play.

Thus for example, with respect to intra-generational equity, in urban areas, do all people have access to resources to grow food, or do wealthier neighborhoods have better access than others? Or do low-income and colored community groups receive the same incentives and other means to install and generate renewable energy as corporations do? Or at regional scale, do downstream water rights and consumption reduce fishing and farming livelihoods of people upstream? And globally how do food choices impact distant ecosystems and communities?

Regarding inter-generational equity, consideration should be given to how an action impacts the ability of people to meet their needs and live decent lives in the future. This would require maintaining or in most cases, enhancing current conditions. Thus for example, acting to preserve urban farmland will ensure future generations have the opportunity to produce food locally. Or creative partnerships between downstream and upstream water users can result in long-lasting benefits for all, whereas large-scale water infrastructure projects creates large debt burdens to be repaid by future water consumers. Example questions to be answered include:

- How does the experiment influence people’s ability to access food, water and energy?
- To what extent does the experiment maintain or improve food, water and energy flows?
- To what extent does the experiment impact the distribution of food, water and energy flows?
- To what extent does the experiment benefit people equally (within and across generations)?

6.5.2 Data for answering the questions

Indicators for intra-generational equity focus on data that illustrate a socio-economic-cultural or spatial variation in outcomes resulting from the ULL activities. For example:

- Percentage of people in the locus of the lab/experiment who are excluded from its benefits due to cultural factors, such as non-native language speaker

- Percentage of people in the locus of the lab/experiment who are excluded from its benefits due to income/wealth
- Percentage of people in the locus of the lab/experiment who are excluded from its benefits due to race or religion, either explicitly or implicitly
- The degree to which an action has a negative impact on people in other communities
- The degree to which people benefit from the lab/experiment who are not part of the local community

Indicators for inter-generational equity focus on data that illustrate an increase of future risk or burdens, denial of future opportunities, or a reduction in future capabilities.

- Long-term debt taken on by cities or communities (future burden)
- Local ownership of resources and assets (future control or opportunity)
- Community embedded schools and education
- The degree of commitment to large-scale, rigid systems that lock-in future populations and deny future change possibilities

6.5.3 Potential difficulties

See general issues in analyzing outcomes.

6.5.4 Example answers

Examples from two living labs in early stages are given, the first a sustainable food economy and enterprise living lab, and the second a sustainable housing living lab.

- Enterprises are created or adapted such that
    - they support the ability of people in other regions to provide for their basic needs, livelihoods, economic opportunities, and to regenerate their local environment. Concepts of justice may be extended in the enterprise's mission to recognize rights of other species and the environment. This would include the enterprise taking an active role in broader societal activities such as community volunteering or political advocacy, to protect these rights.
    - the social, economic and environmental benefits are fairly distributed and make a positive contribution to redressing existing inequities by making special provision to include and make accessible the benefits to those who need it most. For example, access to fresh healthy food is specifically targeted at food deserts; food, water and energy are within low-income family budgets; jobs are created in areas with low employment prospects; enterprises prioritize creating community wealth, rather than just jobs.
    - they do not borrow water, energy, nutrients, land, wealth, labor, and such like from the future in order to produce food today. The mission of the enterprise may be written to legally require future rights of people, species and the environment to be protected. This would include the enterprise taking an active role in broader societal activities to protect future rights.

- The innovations are offered in a social housing estate. This guarantees that the innovations are fully affordable to low-income households. The innovations are also planned to stay for at least 30 years. This means future generations may be able to benefit from the lessons learnt and technologies used in the experiment, but the actual innovations within the SUPERLOCAL area will probably not last much longer than 50 years. As the experiment furthermore designs a locally closed water cycle, other regions will not be negatively affected (i.e. no water will be extracted from other regions, less energy will be extracted from elsewhere). The experiment does not change the food supply to the inhabitants; only food waste is managed via the experiment.

6.5.5 References

Articles describing outcomes and / or providing guidance on their analysis:

- Gibson (2006)
- Luederitz et al. (2017)
- Wiek and Forrest (2017)

Articles providing examples of sustainability outcomes analysis:

- Larson et al. (2013)
- Kuzdas et al. (2016)
- Forrest and Wiek (2014)

6.6 Resource Maintenance and Efficiency

6.6.1 Description on the construct

This construct refers to outcomes that affect the overall material and energy efficiency with which human and social wellbeing benefits can be met. Ultimately this aims for production and consumption systems to operate indefinitely based on the 100% use of renewable resources, and includes three strategies of: 1) minimizing consumption; 2) maximizing production efficiency; and 3) maximizing renewable inputs at the expense of non-renewables. Resources include:

- primary inputs, including energy in a variety of forms, water, land, soil, minerals, fisheries and forests,
- secondary inputs from agriculture, silviculture ad so forth such as fiber and grain staples
- Systems that support recycling of resources and conditions for healthy production, including the climate and watersheds

Minimizing consumption includes not only reducing the amount of goods consumed, but also selectively choosing to consume goods that embody less resources in their production, and that provide benefits to human and social well-being rather than material wealth. For example, plant-based foods are in general an order of magnitude more efficient than meat-based and can provide equal or superior human wellbeing.

Maximizing production efficiency means reducing production while still maintaining the same level of outputs, which effectively means eliminating process waste, whether it be energy or water losses, input material losses, or unused process by-products. Production also includes transport and distribution of products to consumers. Production efficiency may be increased through one or more of: advanced technology and methods, optimized procedures and scheduling, efficiencies of scale, better equipment and machinery, or reducing transportation distances.

Maximizing renewable inputs means replacing non-renewable energy and material inputs with renewable ones. This generally consists of generating resources on-site from renewable sources, or using recycled materials. For energy, this might include onsite energy generation such as solar, wind, or bioreactor, or capturing and using waste heat, or participating in district-scale renewable energy systems, or selectively purchasing renewable electricity from utilities. For water, it could include rainwater harvesting and stormwater capture, process water filtering and re-use, supporting district-scale green infrastructure, or entering into partnerships with other water system scale (e.g. river basin) stakeholders to reduce overall water extraction. For organic materials, it could include composting and anaerobic digestion. For packaging, it would include using recycled materials (e.g. boxes, glass, cans) as well as packaging take-back and re-use. Example questions to be answered include:

- To what extent does the experiment impact renewable and non-renewable inputs (water, land and soil, energy sources)?
- To what extent does the experiment influence demand/ pressure on resources?
- To what extent does the experiment guarantee a more efficient use of food, energy or water (or inputs to food)?
- To what extent does the experiment limit losses/ spillage (of food, energy and water)?

6.6.2 Data for answering the questions

Example of indicators include:

- Amount and percentage of renewable energy used
- Amount and percentage of renewable water used
- Market share of sustainably farmed products (community or city level)
- Proportion of plant-based to meat-based food in local diet
- Percentage of solid waste
- Number of closed loop systems and quantity of energy/material recycled
- Number of external connections and quantity of energy/material transferred (circular economy)

6.6.3 Potential difficulties

See general issues in analyzing outcomes.

6.6.4 Example answers

Examples from two living labs in early stages are given, the first a sustainable food economy and enterprise living lab, and the second a sustainable housing living lab.

- Food production and distribution (farming, transport, processing, etc) minimizes material inputs, uses local renewable inputs, incorporates closed loop systems. The enterprise enters into partnerships or organizations that enable such efficiencies at greater scales and outside the scope of the enterprise's operations
- The use of non-renewable energy is limited because of the experiment (i.e. food and –toilet waste are re-used to create biogas, and heat from shower wastewater is re-used). The use of energy per unit use will therefore be lowered. Also the water used for toilet visits will be reduced by a factor 6-8. Besides, treating water locally may be less efficient from an economic point of view (i.e. infrastructures for central water treatment are already in place), but once the local treatment functions optimally, it may also contribute to costs-savings (e.g. maintenance of pipes and large treatment plants).

6.6.5 References

Articles describing outcomes and / or providing guidance on their analysis:

- Gibson (2006)
- Luederitz et al. (2017)
- Wiek and Forrest (2017)

Articles providing examples of sustainability outcomes analysis:

- Larson et al. (2013)
- Kuzdas et al. (2016)
- Forrest and Wiek (2014)

6.7 Socio-ecological Stewardship and Democratic Governance

6.7.1 Description on the construct

This construct refers to the capacity, knowledge, and degree of participation of stakeholders in community or wider urban planning, implementation and decision-making. This is not referring especially to involvement in the experiment or lab activities (this is part of the lab/experiment inputs), but to more general involvement in civic participation towards a more engaged, active and empowered citizenry with respect to broad sustainability goals. Thus, do lab activities and experiments have an impact on this construct?

6.7.2 Data for answering the questions

Indicators may include:

- Number of community groups involved in FWE activities
- Number of people who are active members of community groups
- Reach / attendance of community events related to FWE developments
- Number and degree of interaction between community groups and local government or public utilities (water, energy)
- Number of partnerships and collaborative projects involving community groups

- Degree of awareness and knowledge among community members of FEW issues and sustainability more broadly
- The degree to which future generations are represented in planning and decision-making

6.7.3 Potential difficulties
See general issues in analyzing outcomes.

6.7.4 Example answers
Examples from two living labs in early stages are given, the first a sustainable food economy and enterprise living lab, and the second a sustainable housing living lab.

- Enterprises are created or adapted such that all workers or members are empowered by having an equitable part in decision making at all levels (operational, management, strategic) commensurate with their activity levels within the enterprise or degree to which they are affected by the enterprise. The enterprise is also required to consider the rights of other people, species and the environment who cannot be directly involved in decision making by, for example, appointing a board member to be their representative. Enterprises are also created or adapted such that they take a long-term view and consider the rights and impacts on all future workers or members or communities, or on other species and the environment. For example, enterprises may assign a board member as a specific guardian for the future.

- Future stakeholders (both short term and intergenerational) are not explicitly involved/ considered in the first stages of the experiment. The main reason is that no people are living in the SUPERLOCAL area at the moment. It is also not known who will be living there after completion of the residential areas/ dwellings. In the design of the experiment, the involved actors try to consider potential concerns and desires from inhabitants. For example, they paid attention to reducing the noise from flushing vacuum toilets and they weighted the advantages and disadvantages of food grinders per apartment and per floor (in the high-rise building). The innovations will formally be owned by the housing corporation who rents the apartments, but as the residents will use the innovations within the private sphere of their homes, we expect them to have a sense of ownership over the innovations once they live there.

6.7.5 References
Articles describing outcomes and / or providing guidance on their analysis:

- Gibson (2006)
- Luederitz et al. (2017)
- Wiek and Forrest (2017)

Articles providing examples of sustainability outcomes analysis:

- Larson et al. (2013)
- Kuzdas et al. (2016)
- Forrest and Wiek (2014)

6.8 Precaution and Adaptation

6.8.1 Description on the construct

This construct captures the degree to which uncertainty is dealt with in decision-making, planning, and implementation activities. Uncertainty is an ever-present in today's world as natural and human systems are put under increasing stress and change happens at accelerated rates. There are multiple risks of systemic failures, such as economic crash, health epidemics, or climate related disasters. In addition, slower but constant change presents further challenges such as new technologies, resource depletion, increasing populations, and biodiversity loss. To what extent, then, do the lab activities and experiments lead to communities and the city being better prepared for this uncertain future? This includes consideration of whether communities and the city able to withstand shocks and disturbances (social, environmental, economic), but also to change as conditions change (external and internal). This relates to the knowledge of stakeholders, their capacity to plan for the future and solve problems together, the design of physical and social systems, the monitoring and assessment of threats, the ability to proactively adapt systems, and the readiness to respond to shocks.

8.8.2 Data for answering the questions

Indicators could include:

- The degree of commitment to large-scale, rigid systems that lock communities and the city into particular pathways and preclude other options
- The general level of awareness / understanding of future risks and uncertainty
- The existence of risk monitoring and assessment systems and escalation plans
- The number and attendance/reach of capacity building events
- The existence of plans to deal with known threats (e.g. climate adaptation plan, water-scarcity plan)
- The implementation of plans, i.e. the number of actions / projects / solutions implemented
- The degree of diversity and redundancy in FWE and related systems and the existence of 'safe-fail' mechanisms

6.8.3 Potential difficulties

See general issues in analyzing outcomes.

6.8.4 Example answers

Examples from two living labs in early stages are given, the first a sustainable food economy and enterprise living lab, and the second a sustainable housing living lab.

- Enterprises are created or adapted such that they build in: education about broad-based sustainability and local/global impacts related to enterprise operations; periodic reflection about the enterprise sustainability performance; staying informed about social / environmental / economic / political events and trends; taking action within the enterprise to change operations; actively intervening outside the enterprise; forming partnerships and being member of associations that can help to understand possible future problems and solutions.

- One of the underlying aims of the experiment is to better anticipate on the effects of climate change. For Kerkrade, these threats include more droughts in the summer period, and more intense rain peaks (all year). Rain peaks may cause a lot of problems such as floods, erosion and overburdening the sewage systems (in extreme cases the sewage system may drain back in people's houses (e.g. toilet, kitchen sink). Further, the main uncertainties the experiment is dealing with relate to human behavior and use of the innovations. Will future inhabitants use the innovations in the right way? If they don't (e.g. by throwing away drug-waste in the vacuum toilets, by grinding garden waste in the grinders, by allowing their dogs to use the filter area as toilet) this may seriously effect the impacts of the innovation. In the experimental dwellings there is still room for failure, but once people live in the apartments, failure of the entire system would not be an option. Potentially, water can be supplied centrally again in the future, but it will take time to prepare all connections. For the sewage connections, this may be even more complicated.

6.8.5 References

Articles describing outcomes and / or providing guidance on their analysis:

- Gibson (2006)
- Luederitz et al. (2017)
- Wiek and Forrest (2017)

Articles providing examples of sustainability outcomes analysis:

- Larson et al. (2013)
- Kuzdas et al. (2016)
- Forrest and Wiek (2014)

GLOCULL URBAN LIVING LABS

Bibliography

Aroca-Delgado, R., Pérez-Alonso, J., Callejón-Ferre, Á., & Velázquez-Martí, B. (2018). Compatibility between crops and solar panels: An overview from shading systems. . *Sustainability, 10*.

Bernstein, M., Wiek, A., Brundiers, K., Pearson, K., Minowitz, A., Kay, B., & Golub, A. (2014). Mitigating urban sprawl effects: a collaborative tree and shade intervention in Phoenix, Arizona, USA. . *Local Environ.*, 1-18. doi:http://dx.doi.org/10.1080/13549839.2014.965672

Bos, J., & Brown, R. (2012). Governance experimentation and factors of success in socio-technical transitions in the urban water sector. . *Technol. Forecast. Soc. Change, 79*(7), 1340-1353. doi: http://dx.doi.org/10.1016/j.techfore.2012.04.006

Bulkeley, H., Coenen, L., Frantzeskaki, N., Hartmann, C., Kronsell, A., Mai, L., . . . Voytenko Palgan, Y. (2016). Urban living labs: governing urban sustainability transitions. . *Current Opinion in Environmental Sustainability, 22*, 13-17.

Ceschin, F. (2014). How the design of socio-technical experiments can enable radical changes for sustainability. *Int. J. Des., 8*(3), 1-21.

Dinesh, H., & Pearce, J. (2016). The potential of agrivoltaic systems. . *Renewable and Sustainable Energy Reviews, 54*, 299-308.

Dupraz, C., Marrou, H., Talbot, G., Dufour, L., A., N., & Ferard, Y. (2011). Combining solar photovoltaic panels and food crops for optimising land use: Towards new agrivoltaic schemes. . *Renewable Energy, 36*, 2725-2732.

Enengel, B., Muhar, A., Penker, M., Freyer, B., Drlike, S., & Ritter, F. (2012). Co-production of knowledge in transdisciplinary doctoral theses on landscape development-An analysis of actor roles and knowledge types in different research phases. . *Landscape and Urban Planning, 105*(1-2), 106-117.

Evans, J., & Karvonen, A. (2014). Give me a Laboratory and I Will lower your carbon footprint!" - urban laboratories and the governance of low-carbon futures. . *Int. J. Urban Reg. Res., 38*(2), 413-430. doi:http://dx.doi.org/10.1111/1468-2427.12077

Forrest, N., Stein, Z., & Wiek, A. (2019). Water-independent residential properties as a transformational solution to achieve water sustainability in desert cities? *Journal of Cleaner Production 214 (Mar)*, 1038-1049 doi:10.1016/j.jclepro.2018.12.309

Forrest, N., & Wiek, A. (2014). Learning from success—Toward evidence-informed sustainability transitions in communities. *Environmental Innovation and Societal Transitions, 12*, 66-88. doi:https://doi.org/10.1016/j.eist.2014.01.003

Frantzeskaki, N., Wittmayer, J., Loorbach, D., & (2014). The role of partnerships in "realising" urban sustainability in Rotterdam's City Ports Area, The Netherlands. . *J. Clean. Prod., 65*, 406-417. doi:http://dx.doi.org/10.1016/j.jclepro.2013.09.023.

Funtowicz, S., & Ravetz, J. (1993). Science for the post-normal age. *Futures, 25*(7), 739-755. doi:https://doi.org/10.1016/0016-3287(93)90022-L

Gibson, R. (2006). Sustainability assessment: Basic components of a practical approach. *Impact Assessment and Project Appraisal, 24*(3), 170.

Karvonen, A., & van Heur, B. (2014). Urban laboratories: experiments in reworking cities. *Int. J. Urban Reg. Res. , 38*(2), 379-392. doi:http://dx.doi.org/10.1111/1468-2427.12075

Kuzdas, C., Warner, B., Wiek, A., Vignola, R., Yglesias, M., & Childers, D. (2016). Sustainability assessment of water governance alternatives: The case of Guanacaste Costa Rica. *Sustainability Science, 11*(2), 231-247.

Lang, D., Wiek, A., Bergmann, M., Stauffacher, M., Martens, P., Moll, P., . . . Thomas, C. (2012). Transdisciplinary research in sustainability science: practice, principles, and challenges. . *Sustain. Sci., 7*, 25-43. doi:http://dx.doi.org/10.1007/s11625-011-0149-x

Larson, K., Wiek, A., & Withycombe Keeler, L. (2013). A comprehensive sustainability appraisal of water governance in Phoenix, AZ. *Journal of Environmental Management, 116*, 58-71. doi:https://doi.org/10.1016/j.jenvman.2012.11.016

Luederitz, C., Schäpke, N., Wiek, A., Lang, D., Bergmann, M., Bos, J., . . . Westley, F. (2017). Learning through evaluation – a tentative evaluative scheme for sustainability transition experiments. *Journal of Cleaner Production, 169*, 61-76.

Marrou, H., Guilioni, L., Dufour, L., Dupraz, C., & Wery, J. (2013). Microclimate under agrivoltaic systems: Is crop growth rate affected in the partial shade of solar panels? *Agricultural and Forest Meteorology, 177*, 117-132.

Marrou, H., Wery, J., Dufour, L., & Dupraz, C. (2013). Productivity and radiation use efficiency of lettuces grown in the partial shade of photovoltaic panels. *European Journal of Agronomy, 44*, 54-66.

Moore, J., Pagani, F., Quayle, M., Robinson, J., Sawada, B., Spiegelman, G., & Van Wynsberghe, R. (2005). Recreating the university from within: collaborative reflections on the University of British Columbia's engagement with sustainability. *Int. J. Sustain. High. Educ., 6*(1), 65-80. doi:http://dx.doi.org/10.1108/14676370510573140.

Nevens, F., Frantzeskaki, N., Gorissen, L., & Loorbach, D. (2013). Urban Transition Labs: co-creating transformative action for sustainable cities. *J. Clean. Prod., 50*, 111-122. doi:http://dx.doi.org/10.1016/j.jclepro.2012.12.001

Nevens, F., & Roorda, C. (2014). A climate of change: a transition approach for climate neutrality in the city of Ghent (Belgium). . *Sustain. Cities Soc., 10*, 112-121. doi:http://dx.doi.org/10.1016/j.scs.2013.06.001

Offermans, A., Dalla Fontana, M., Moreira, F., Wahl, D., Ness, B., Mitrofanenko, T., . . . Bernert, P. (2019). *GLOCULL Midterm report.* Retrieved from Maastricht:

Offermans, A., & Kemp, R. (2016). Successfull joint knowledge production: beyond credibility, saliency and legitimacy. In R. Cörvers, J. De Kraker, R. Kemp, P. Martens, & H. van Lente (Eds.), *Sustainable development research at ICIS: taking stock and looking ahead.* (pp. 299-310). Maastricht: Datawyse Universitaire Pers Maastricht.

Ryan, C. (2013). Eco-Acupuncture: designing and facilitating pathways for urban transformation, for a resilient low-carbon future. . *J. Clean. Prod., 50*, 189-199. doi:http://dx.doi.org/10.1016/j.jclepro.2012.11.029.

Schäpke, N., Stelzer, F., Caniglia, G., Bergmann, M., Wanner, M., Singer-Brodowski, . . . Lang, D. (2018). Jointly experimenting for transformation? Shaping real-world laboratories by comparing them. . *GAIA, 27*(S1), 85-96.

Scholl, C., Ablasser, G., Agger Eriksen, M., Baerten, N., Blok, J., Clark, E., . . . Zimmermann, F. (2017). *Guidelines for Urban Labs*.

Schreuer, A., Ornetzeder, M., & Rohracher, H. (2010). Negotiating the local embedding of socio-technical experiments: a case study in fuel cell technology. . *Technol. Anal. Strateg. Manag., 22*(2), 729-743. doi:http://dx.doi.org/10.1080/09537325.2010.496286

Schünemann, F. (2018). *Economy-wide policy modeling on the food-energy-water nexus: identifying synergies and tradeoffs on food, energy and water security in Malawi.* Berlin Peter Lang GmbH.

Taplin, H., & Clark, H. (2012). *Theory of Change Basics: a primer on theory of change*. Retrieved from New York: http://www.theoryofchange.org/wp-content/uploads/toco_library/pdf/ToCBasics.pdf

Trencher, G., Terada, T., Yarime, M., & (2015). Student participation in the co-creation of knowledge and social experiments for advancing sustainability: experiences from the University of Tokyo. *Curr. Opin. Environ. Sustain., 16*, 56-63. doi:http://dx.doi.org/10.1016/j.cosust.2015.08.001.

Van Mierlo, B., & Beers, P. (2015). *Reflexivity and learning in the context of system innovation; Prying loose entangled concepts.* Paper presented at the International Sustainability Transition Conference 2015., Brighton, UK.

van Straalen , N. (2018). *Encyclopedie van de evolutiebiologie: Met speciale aandacht voor de evolutie van de mens*: ENSI.

Vandevyvere, H., Nevens, F., & (2015). Lost in transition or geared for the S-Curve? An analysis of flemish transition trajectories with a focus on energy use and buildings. *Sustainability, 7*(3), 2415-2436. doi:http://dx.doi.org/10.3390/su7032415.

Wiek, A., & Forrest, N. (2017) A framework for inventorying, analyzing, evaluating, and extrapolating sustainable integrated water solutions. In.

Wiek, A., Kay, B., & Forrest, N. (2015). Worth the Trouble?! an evaluative scheme for urban sustainability transition labs (USTL) and an application to the USTL in Phoenix, Arizona. In N. Frantzeskaki, L. Coenen, V. Castan Broto, & D. Loorbach (Eds.), *Urban Sustainability Transitions.*: Routledge.

Wiek, A., Talwar, S., O'Shea, M., & Robinson, J. (2014). Toward a methodological scheme for capturing societal effects of participatory sustainability research. *Res. Eval., 23*(2), 117-132. doi:http://dx.doi.org/10.1093/reseval/rvt031.

Wittmayer, J., & Schapke, N. (2014). Action, research and participation: roles of researchers in sustainability transitions. *Sustain. Sci*, 483-496. doi:http://dx.doi.org/10.1007/s11625-014-0258-4

Wolfram, M. (2016). Conceptualizing urban transformative capacity: A framework for research and policy. . *Cities, 51*, 121-130.

Wolfram, M., Frantzeskaki, N., & Maschmeyer, S. (2016). Cities, systems and sustainability: status and perspectives of research on urban transformations. . *Current Opinion in Environmental Sustainability, 22*, 18-25.