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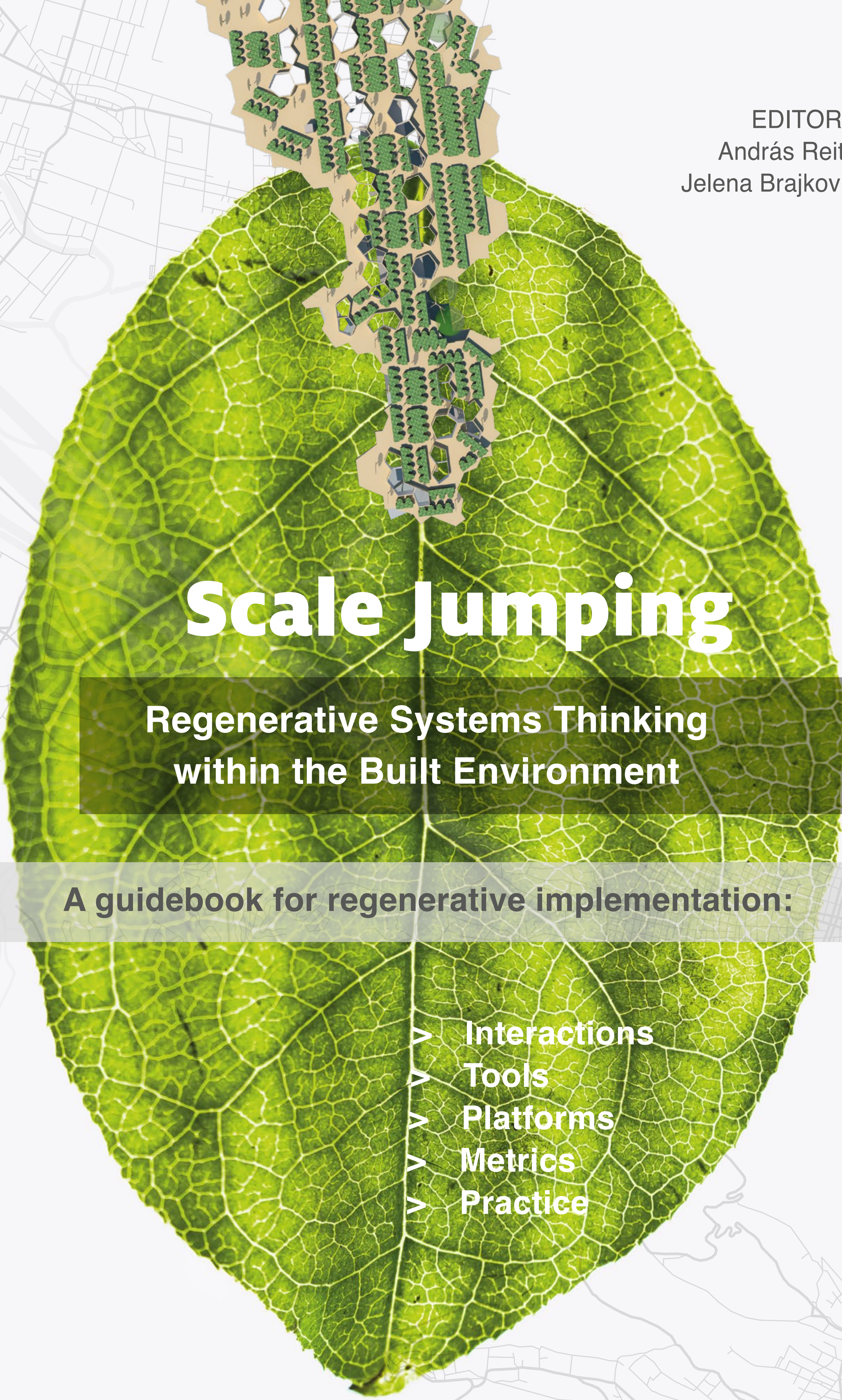

Scale Jumping

Regenerative Systems Thinking within the Built Environment

A guidebook for regenerative implementation:

> Interactions
> Tools
> Platforms
> Metrics
> Practice

RESTORE
REthinking Sustainability TOwards a Regenerative Economy

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COST Action CA16114 RESTORE:
REthinking Sustainability TOwards a Regenerative Economy,
Working Group Five Publication: SCALE JUMPING

SCALE JUMPING ›››

Regenerative Systems Thinking within the Built Environment

A guidebook for regenerative implementation:
interactions, tools, platforms, metrics, practice

EDITORS
András Reith, Jelena Brajković

COST is supported by the EU Framework Programme Horizon 2020

IMPRESSUM

RESTORE Working Group Five:

Scale Jumping: Regenerative Systems Thinking within the Built Environment. A guidebook for regenerative implementation: Interactions, tools, platforms, metrics, practice

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ISBN 978-3-9504607-8-0 *(Online version)*
ISBN 978-3-9504607-9-7 *(Printed version)*

COST Action CA16114 RESTORE:
REthinking Sustainability TOwards a Regenerative Economy

Project Acronym	RESTORE
Project Name	REthinking Sustainability TOwards a Regenerative Economy
COST Action	CA16114
Action Chair	Carlo BATTISTI (Eurac Research)
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Grant Holder institution	Eurac Research, Institute for Renewable Energy Viale Druso 1, Bolzano 39100, Italia t +39 0471 055 611
Project Duration	2017 – 2021
Website	www.eurestore.eu
COST Website	www.cost.eu/COST_Actions/ca/CA16114

Graphic design	Pluristamp / Eurac Research / Jelena Brajković
Print	Esperia Srl
Proofreading/Editing	Antony Ross PRICE (Transap)

Citation: Reith, A., Brajković, J. (2021). *Scale Jumping: Regenerative Systems Thinking within the Built Environment. A guidebook for regenerative implementation: Interactions, tools, platforms, metrics, practice.* COST Action CA16114 RESTORE, Working Group Five: Scale Jumping, printed by Eurac Research (Bolzano, IT).

This publication is based upon work from COST Action RESTORE CA16114, supported by COST (European Cooperation in Science and Technology). COST (European Cooperation in Science and Technology) is a pan-European intergovernmental framework. Its mission is to enable break-through scientific and technological developments leading to new concepts and products and thereby contribute to strengthening Europe's research and innovation capacities. It allows researchers, engineers, and scholars to jointly develop their own ideas and take new initiatives across all fields of science and technology, while promoting multi- and interdisciplinary approaches. COST aims at fostering a better integration of less research-intensive countries to the knowledge hubs of the European Research Area. The COST Association, an International not-for-profit Association under Belgian Law, integrates all management, governing and administrative functions necessary for the operation of the framework. The COST Association has currently 36 Member Countries. www.cost.eu

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Map data: Google, ©2020 / Brigittasquare aerial view, Vienna

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forward-looking strategies *gentle introduction to systems thinking* regenerative city patterns The Good Urban Life regenerative scale jumping innovative urban strategies scale jumping potentials RESTORE Working Group 5 (WG5) *urban planning and architecture, structural engineering and smart grids, life-cycle assessments,* green buildings, biophilia, emerging technologies, human geography, education, socially driven and participative design, *environmental policies, restorative economies, legislation and implementation* mutual objective architectural offices, consultancy firms, urban planning government departments, policy-making stakeholders academics **multidisciplinary approach versatile results** regenerative-design innovations forward-looking strategies *gentle introduction to systems thinking* regenerative city patterns The Good Urban Life regenerative scale jumping innovative urban strategies

ACKNOWLEDGEMENTS

by the Editors

In this book, scale jumping potentials and approaches within regenerative practice are explored. It addresses the possibilities, problems and challenges of applying systems thinking to work towards the regenerative growth of our built environments. The publication presents the activities of the final RESTORE Working Group 5 (WG5) whose tasks were not only to investigate current frontiers in regenerative research and practice, but also to look into the future of regenerative implementation, through a systems thinking approach and systemic analyses of interactions, tools, platforms and metrics. As WG5 is the final RESTORE Working Group, it has drawn from the strategies and findings developed within the preceding four RESTORE Working Groups to discern future directions for the human-nature-built environment nexus.

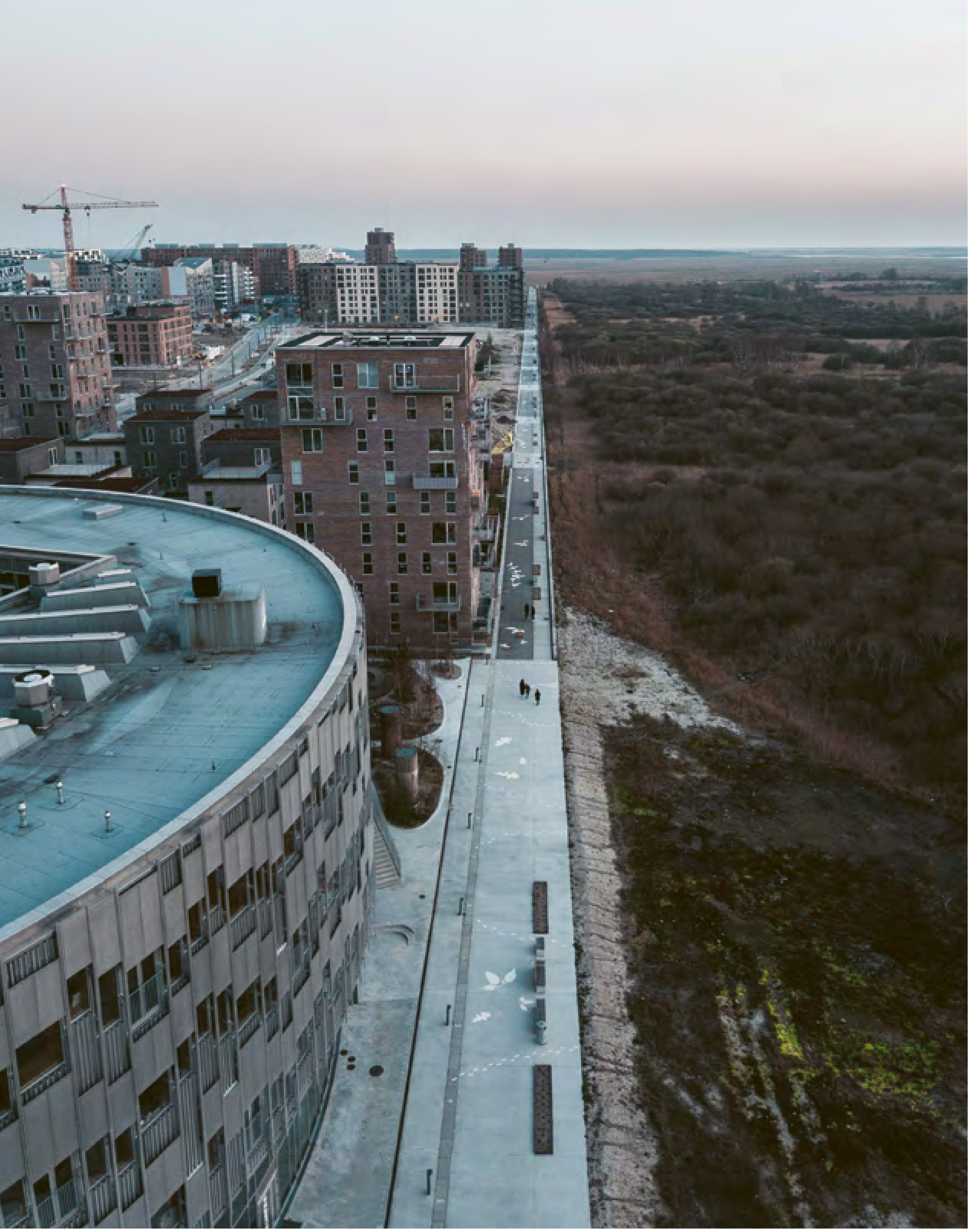
RESTORE WG5 comprises many professionals and academics whose different backgrounds have approached regenerative design and implementation through a multidisciplinary, holistic vision to achieve its goals. Since its formation up until the time of this publication, WG5 has been and is still a forum for active conversation between its many members, partners and collaborators. Fields of expertise comprising over 80 professionals and academics working towards WG5 goals, range from urban planning and architecture, structural engineering and smart grids, through to life-cycle assessments, green buildings, biophilia, emerging technologies, human geography, education, socially driven and participative design, as well as environmental policies, restorative economies, legislation and implementation.

Working in the challenging times of a global pandemic has strengthened the resolve of RESTORE WG5 to move towards the horizon of a regenerative future where healthier lives for both people and nature can be achieved, environments designed through a holistic approach, and technologies applied to support healthy and meaningful lives and lifestyles. In this section, we would like to thank everybody who has accompanied the RESTORE WG5 programme, striving towards a mutual objective, people who have made the WG5 concept a reality, and have remained active, motivated and creative in spite of the unusually hard and complex working conditions of 2020.

Firstly, as the Editors, we would like to thank the contributors to this book, numbering over 50. Their fields of expertise vary, as mentioned above, from architecture and urban planning to social sciences, economy and policy making. Their profiles and backgrounds are diverse – professionals working in architectural offices, consultancy firms, urban planning government departments, policy-making stakeholders, and academics - PhD and ECI researchers, as well as tenured University professors. This tapestry of expertise within WG5 reflects a creative multidisciplinary approach that is the source of such carefully planned and versatile results and findings.
The contents of each chapter and the work of each contributor have been masterfully curated by the lead authors of each chapter to whom we express our sincere gratitude for having coordinated and illustrated their topics in such a clear format oriented towards future developments: Martin Brown, Jelena Brajkovic, Naomi Morishita-Steffen, David Calas, Edeltraud Haselsteiner, Emanuele Naboni, Francesco De Luca, Dorota Kamrowska-Zaluska, Barry Hayes, Odysseas Kontovourkis, Paola Villoria Sáez, Eduardo Blanco, Željka Kordej-De Villa and Klaudia Ecker (ordered by authorship of chapters) all expended great effort on conceptualizing and structuring the content of their chapters, and editing, coordinating and delivering planned outcomes.
We would like to give special thanks to Martin Brown for supporting and dedicating time to rethinking the concepts of some parts of this book, as well as for intensive consultancy on the current state of the art and the variety of regenerative-design innovations, as well as forward-looking strategies. We also thank Francesco Gonella who put together a gentle introduction to systems thinking and its application in the context of regenerative city patterns. Our gratitude extends to everybody involved in the management, administration and editing of this book. We likewise wish to thank both the RESTORE management committee members and the RESTORE core group, especially Carlo Battisti, Roberto Lollini and Ilaria Alberti for all their helpful, constant and active support. A note of thanks as well to Antony Price, for his thorough proofreading and sharp and persuasive comments that have contributed to the clarity and concision of each chapter.
Besides this book, the goals that we set within RESTORE WG5 were achieved through our many activities, meetings, published papers, conferences attended and Short Time Scientific Mission (STSM) enrolments. The conversation, initiated in February 2020, was subsequently implemented in practical surroundings with WG5 "Jump

2030 – The Good Urban Life" (A Holistic Vision for the Brigittaplatz/Hannovermarkt in the 20th district of Vienna) Training School and Online Conference held in hybrid mode, in September 2020, in Vienna. Holding firm to our intentions, we held a Training School and Online Conference with the aim of investigating regenerative scale jumping approaches for 2030, in the ideal setting of one of the world's foremost cities for quality of life, with a long-standing tradition of nurturing, adopting, and developing innovative and meaningful urban strategies.
We are sincerely thankful to our Local Organizing Committee for the perfect preparations and masterful organization of "Jump 2030 – The Good Urban Life" Training School (TS) in Vienna - David Calas, Anna-Vera Deinhammer and Marcello Turrini. Thanks to their enthusiasm and effort, they conceptualized and organized a training school with a high-quality programme. We thank our international trainers Jelena Brajkovic, Viktor Bukovszki and Emanuele Naboni for providing us with expertise in different areas, from biophilic design to use of Space Syntax for making life thrive in buildings and urban spaces. We thank all conference keynote speakers for providing us with multiple insights into regenerative urban planning: Carlo Battisti, Martin Brown, David Calas, Anna-Vera Deinhammer, Michael Fürst, Paul Schulz, Julia Girardi-Hoog, Roman Grünner, Daiva Jakutyte-Walangitang, Dorota Kamrowska-Zaluska, Johannes Kisser, Christian Knapp, Roland Krebs, Stefan Melzer, Haris Piplas, David Tudiwer, Maria Vassilakou. We must also express appreciation for our respected TS5 Jury: Christian Knapp, Bernadette Luger, Nikolas Neubert, Haris Piplas, Andras Reith and Karin Stieldorf. Last, but not least, we wish to thank our RESTORE Training School Coordinator, Dorin Beu, for efficient and effective support whenever needed. In numbers: 16 trainees, 3 international trainers, 3 local trainers, 16 keynotes/speakers, 3 site visits, 1 exhibition, 5 jury members and 1 final presentation, all at the Vienna Training School and Online Conference; a successful contribution to our Scale Jumping 2030 Challenge.

Finally, we would like to thank all the institutions that have supported the activities and research of this working group. COST RESTORE, EURAC Research, ABUD Budapest, University of Belgrade – Faculty of Architecture, International Living Future Institute, Stadt Wien, Gebietsbetreuung Stadterneuerung, AIT (Austrian Institute of Technology) and many, many more, that constitute the network of the WG5 Scale Jumping Nexus. We earnestly look forward to further collaboration and work on scale jumping regenerative topics.



Ørestaden, Copenhagen, Photo by Hjalte Gregersen, Unsplash

INTRODUCTION

by Jelena BRAJKOVIĆ

As we progress further into the 21st century, the sorts of environments we have built for ourselves are becoming clearer to all, whether inside or outside regenerative practice, as are the features that are provoking serious damage to both human health and natural resources. One may ask how have we arrived at built environments with such effects on both humans and nature and why do we allow these features? And how can we mend all the broken links within the human-nature-built environment nexus? How has progress, mostly technological and of the human kind, shaped the built environments as we know them, and how has *progress* led to such unhealthy living conditions, unhealthy habits and such careless treatment of nature? Industrialization, automatization of manufacturing processes, improving transport, economic growth, new media and materials, digital tools, presence of networks, nanotechnologies etc. each revolution led to some new possibilities for designing built environments, and with much exuberance, technologies have been tested among humans, implemented and developed into design and manufacturing processes. Through different aspects of our built environments we can notice the imprints of different technologies, whether used as tools or as media. As Mario Carpo noted, the rise of printed media led to a revolution in communicating architectural images and design standardization - predesigned architecture was enabled. With industrialization, standardized production and manufacturing was enabled, which subsequently led to the standardized visual outputs, landscapes and environments. And, the emergence of digital media is pushing us towards a stage of non-standard technologies, variability, emergent theories and organic forms, customization, interactivity and digitally supported participative design (Carpo, 2011). Digital technologies enabled urban planners and architects to consider many new features of interest. In numerous design processes, the focus has shifted from material and object-based to process-oriented design, and systems behaviour assessment. Rachel Armstrong remarked that 21st century society is less determined by objects and increasingly shaped by connectivity (Armstrong, 2013). With networks and high-tech environments, Roy Ascott argues that there is no longer a binary opposition between town and country, urban and rural… Ascott even calls connectedness a new principle of life, an evolutionary stage in human development (Ascott, 2003). Networked environments have enabled us to live *glocally* and mediation is everywhere around us. How can we control and guide the future development of our environments? How do we connect to nature? Can we return to it? How can we develop technologies that support simple and healthy life and nature, rather than the opposite? Those are only a few of the questions that are assuming a sense of urgency within regenerative discourse.

Besides the fast pace of technological development and the need for guidance, we struggle with the fast pace of degenerative behavior towards nature, environmental problems piling up and the climate-change emergency constantly overlooked as a priority. Average rising temperatures, lower air and food quality, pollutant emissions, intensive commuting, endless economic demands, social inequalities, information overload, the presence of networks, and many others, are all elements of our built environments and factors that influence our physical, physiological and mental health, as well as our relationship with nature. Indeed, our connectivity with the natural world needs to be urgently revised. It is high time for humanity to balance its own needs with artificial and natural elements of our built environments, in a biophilic way, inspiring both people and nature to thrive.

The matrix of elements that shape and drive our environments are becoming more and more interconnected through the fast pace of urban progress and we appear all too easily to be losing control over our own creation, the environments we created ourselves. Within regenerative discourse, holistic and systems thinking approaches are urgently needed and scale-jumping possibilities should be investigated. In this book, the focus is on scale jumping and regenerative systems thinking that have been investigated through holistic approaches, by analysing interactions within the human-nature-built environment nexus, as well as the practice and the implementation of tools, platforms and metrics.

At a more operational and detailed level, the main aim of this book is to explore scale jumping potentials for neighbourhood, city and society-wide level regenerative sustainability, including analysis, solutions and implementation.

Scale Jumping potentials are discussed in this book in both size and quality:

> In size
  - upscale area – thinking beyond building scale
  - upscale reach – influence more people, target new audience

> In quality
  - upscale research potentials – new directions and interactions
  - upscale market potentials – enhance market interest
  - upscale networks – develop interdisciplinary and intersectoral connections

Analysis, solutions and implementations of scale jumping strategies and potentials with regards to systems thinking and holistic approaches are presented through a carefully developed framework

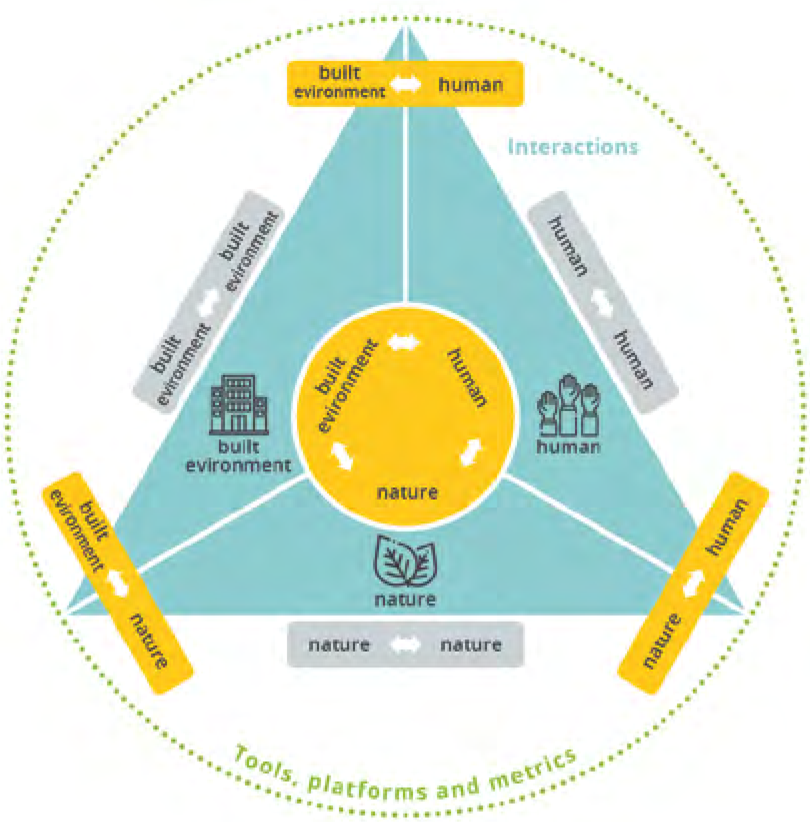


Figure 1. *Scale Jumping Framework, Source: Reith (2020)*

in this book. Following a gentle introduction to systems thinking and its application in the context of regenerative city patterns, it is divided into two main thematic areas: *Interactions* and *Tools, Platforms and Metrics*.

Within its *Interactions* Section, the objective of the book is to analyze interactions within the human-nature-built environment nexus. Three chapters will firstly focus on the triangular human-nature-built environment system and its patterns, as well as some specificities of human-built and nature-built environmental interactions. In this part of the book, both design and place, as well as space, nature, energy, materials, education, equitableness and economies have all been investigated within triangular nexus patterns for scale-jumping approaches and interventions. Human-Built Environment Interactions have been revised through definitions of scale-jumping interactions, Smarter Together case studies, health and the built environment, and a review of sustainability assessment tools for buildings and cities. Nature-Built Environment Interactions have been reviewed through scale jumping opportunities to tackle major urban challenges, through acupunctural smallness – small urban hacks, acupunctural action and process-oriented planning approaches.

Within the Section *Tools, Platforms and Metrics*, the aim is to analyze regenerative implementation through supportive tools, platforms and metrics. This section will offer an overview of current trends within scale-jumping technologies, as well as green transition legislation, all working in support of regenerative goals, and restorative and circular approaches to urban planning. Some of the chapters will be focused on technologies, digital tools to support district regenerative design and scale jumping, smart technologies in the context of regenerative design, the Internet of Things, (big) data, AI, digital twins and emerging technologies; another chapter will be focused on design frameworks and assessment tools in support of scaling up regenerative practices; and the focus of the final chapter will be on legislation and policy documents in support of a green transition.
A fine addition to this book is the *Practice Exercise* chapter that reports *JUMP 2030 - "The Good Urban Life" A Holistic Vision for the Brigittaplatz/Hannovermarkt in the 20th district of Vienna*, Vienna Training School and Online Conference Program, which took place in Vienna (Austria) 21st - 25th September 2020.
Through exploring scale jumping potentials within regenerative practice, through holistic approaches and systems thinking, these Guidelines set out to fill a knowledge gap on the interconnectivity of regenerative aspects within the human-nature-built environment nexus. Its topic of scale jumping is contributing to possible directions for the development of regenerative connections, tools, platforms and metrics. Its systemic approach aims to create a necessary, holistic view of regenerative practice, provoking interconnected, well-informed attitudes and striving to create meaningful connections between humans, nature and their built environment. The book therefore serves as guidelines for all stakeholders eager to scale up an understanding of built environments and their design through regenerative projects.

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Reggio Emilia AV Mediopadana, Italy, Photo by Luca Bravo, Unsplash

1 Interactions

1.1. Human. Nature. Built Environment. Scale Jumping Nexus

The Human, Nature and Built-Environment nexus is visited in this chapter through the consideration of a number of Patterns. It is based on the imaginary of a city that addresses this nexus with symbiotic benefits for both nature and humans. For this chapter, we set ourselves four challenges:

- addressing scale jumping, not just sustainable development;
- addressing regenerative, not just restorative design;
- addressing the human, nature and built-environment nexus;
- addressing Systems Thinking 'leverage points'.

Each of the patterns illustrates the state of the art and the actions that are necessary to scale jump towards a regenerative city or district. The chapter concludes with a checklist of scale-jumping interventions providing a vital guide for progress on our journey towards a regenerative future.
This chapter will be of interest to anyone and everyone in the built environment sector and its supply chains ready to make the scale-jump transition from a sector that has typically and historically shown degenerative approaches to a sector that is truly regenerative.

1.2. Scale Jumping: Human – Built Environment Interactions

This chapter explores the relationships between people and the built environment for scale jumping. The chapter presents guidelines with best practice examples for policy makers and developers and different ways of interpreting scale jumping to meet climate neutrality goals. It clearly illustrates the relations between concepts and actual implementations, and local factors such as co-creation for the inclusion of participative citizenship. Different factors and interactions will be defined in the first section, in view of the many and varied ways to jump in scale. It begins with an exploration of the overall contextual considerations and how scale jumping may be considered within the Restore Project. In the second section, district-level innovations implemented within three different Lighthouse Cities (LHC) will be illustrated as part of the Smarter Together case study. All project partners benefit from an open exchange with stakeholders from academia, local government, local citizens, and innovative SMEs. The relationship between health and the built environment with the essential factors for scale jumping will be explored in the third section. Several international building assessment tools and their relations with Human Building Interactions will be described in the last section, giving special consideration to the impacts of building quality on human health and healthy indoor environments.

1.3. Scale Jumping: Nature – Built Environment Interactions

Small urban hacks, acupunctural action and process-oriented planning approaches might appear to reach out to quite a socio-romantic attitude towards our urban environments. In this chapter, the aim is to remedy such a biased view, demonstrating the impact and potential of smallness in the context of major urban challenges. Small urban hacks and their multi-faceted and creativity-driven approaches of small is beautiful are selected from all over Europe to investigate the rigidity of the existing urban fabric. Small actions are reflected in a quantitative and qualitative way, analysing and critically dissecting their impact, civic acceptance and efforts to achieve a resilient future urban spirit. This meticulous inspection reframes the urban acupuncture standpoint, outlining the possibility for reconciliation between both past and future planning credos in view of present and upcoming urban threats.

2 Tools, Platforms, Metrics

2.1. Digital Tools to Support District Regenerative Design and Scale Jumping

In this chapter, digital environments and how they can support regenerative design at district level are discussed. It introduces the importance of digital tools both for linking domains, to achieve co-benefits, and for linking scales, to achieve scale jumping. The core revolves around the ways that parametric script integration can do the following: develop customized components that address specific issues of regenerative design, share data across domains and scales, resolve conflicting objectives, manage large amounts of data through optimization techniques and find smart design solutions via machine learning.
The audience comprises architects who are involved in - city and building - simulations and building simulationists who wish to extend their range of applications to embrace multi-domain thinking and regenerative design approaches.

2.2. Smart Technologies in the Context of Regenerative Design: IoT, (Big) Data, AI, Digital Twin

In this chapter, the conditions, the smart policies, and the technologies that can boost the process of a paradigm shift towards restorative sustainability are mapped out. In Section 1, the definition of smart cities will be introduced within the context of regenerative design and planning. The focus of Section 2 will be on new peer-to-peer approaches towards sharing and trading resources within smart cities and the co-design of smart sustainable cities. The role of (Big) Data for smart sustainable city planning and management will be introduced in Sections 3 and 4 together with Digital Twin as a tool for enhancing modelling and simulation capabilities in this context. In the final section, the focus will be on neighbourhood sustainability and (non-geographical) energy islands as power grid stabilizers, and buildings as nodes both in micro- and in nano-grids.
The contents of this chapter are addressed at politicians, city planners, and administrators working for municipalities/cities, at regional and national level, as well as at architects and developers in the private sector. We strongly believe that the introduction of regenerative approaches into the planning of smart cities is a key measure in bringing together all the actors shaping the built environment.

2.3. Emerging Technologies

In this chapter, a discussion will be presented of emerging technologies and their application that will move us towards a sustainable approach that is both restorative and regenerative, and aligned with the notion of scale jumping. These technologies are categorized and interrelated within a general framework that includes Information and Communications Technology (ICT), Construction Technologies, Operational Technologies and City Models. Emphasis will then be

given to Construction Technologies with examples that include emerging materials and construction technologies. Several examples where Information and Communications Technology (ICT) and Construction technologies have been applied to City Models at an urban scale will then be outlined. Finally, a discussion and the conclusions on the applicability of emerging technologies on a larger scale will stress their potential and capability for positive contributions to social, economic and sustainable improvements within contemporary society.
Designers, architects, and engineers as well as policy makers and state developers with roles and involvement in design and decision-making related to city planning, construction and the functional operation of cities constitute the main audience for this chapter.

2.4. From regenerative buildings to regenerative urban projects: Design frameworks to scale up within area regenerative practices

In this chapter, a discussion will be presented of design frameworks and assessment tools that are useful for boosting the scale jumping of regenerative design practices and the paradigm shift. The main objective is to identify existing design and assessment frameworks, to describe the way they work and how they can contribute to scale-jumping regenerative design, as well as to identify shortcomings and opportunities. The chapter also showcases and discusses ten design frameworks that practitioners can use to foster regenerative projects on an urban scale.
Urban designers, urban planners, public policy agents, and real-estate developers dealing with urban project design and development constitute the primary audience of this chapter.

2.5. EU policy documents for green transition

The chapter presents a well-structured state-of-the-art review of EU-related policy documents for urban development. A systematic screening offers a transparent and coherent picture of the main strategies over the period 2014-2020 and the coming years and two examples of best practice offer a glimpse of how they may be successfully implemented.
The main audience for this chapter comprises city representatives and decision-makers who wish to understand the dynamics of urban policies at a European-level and how those policies may affect regional or local ecosystems in the near future. It likewise offers information on the main goals and instruments of recent EU strategies that may be useful for different stakeholders and organizations in the field of urban development and sustainability consultation.

3 Practice exercise

JUMP 2030 - "The Good Urban Life"

A Holistic Vision for the Brigittaplatz/Hannovermarkt in the 20th district of Vienna. Vienna (Austria) Training School and Online Conference, 21st - 25th September 2020

This chapter presents the JUMP 2030 - "The Good Urban Life" RESTORE WG 5 Training School in Vienna. 16 trainees, 3 international trainers, 3 local trainers, 16 keynotes/speakers, 3 site visits, 1 exhibition, 5 jury members, 1 final presentation and quite a complex topic addressing the challenging future of urban development: Scale Jump, the working title of WG5. Numbers and content that pretty much sum up what the Training School in Vienna aims to achieve, launching a topic with many social pressures on the urban renewal of an existing neighbourhood, an implementation of social cultural relations, an inclusion of circular considerations and a reflection of biophilic approaches. In short: Jump 2030 'The Good Urban Life' - A Holistic Vision for the Brigittaplatz/Hannovermarkt in the 20th district of Vienna.

All in all, a process-oriented approximation, which was augmented by topic-related keynotes and to which the selected trainee groups had to react with a strategic project proposal. The latter was shared with a broader audience and jury panel, receiving highly valuable feedback on the paths that the project has taken. Finally, a starting point for performing approaches within highly interconnected urban environments is to consider a broad range of planning-related implications. Challenges that are to be faced in the near future and which will hopefully have been shaped at the Training School in Vienna.

Map data: Google, ©2020 / Brigittasquare aerial view, Vienna

A Gentle Introduction to Systems Thinking and its Application in the Context of Regenerative City Patterns

Francesco GONELLA
Dept. of Molecular Sciences and Nanosystems, Ca' Foscari University of Venice, Italy

> The significant problems we face today cannot be solved at the same level of thinking at which they were created.
>
> (A. Einstein)

Einstein's quotation may be found in countless contexts, yet very rarely is it accompanied by any indication whatsoever of what this "new level of thinking" should be. Systems Thinking (ST) may be regarded as a general name that substantiates this new need. It has to do with the ineffectiveness of linear thought at addressing non-linear complex problems. In fact, the conceptual basis of systemic thinking addresses the factual failure of a reductionist, bottom-up approach towards describing, understanding and predicting the behaviour of systems characterized by complex interconnections between their elements and network ties. The emerging necessity is therefore to shift our attention from the study of events -in terms of causes, effects and mutual relationships- to the study of the systems -in terms of patterns, structures and leverage points- from which those events emerge. This paradigm shift will change the epistemic issues relevant to the scientific inquiry: mutual causation structures (feedback loops) replacing the traditional linear chains of cause and effect, and descriptions of self-organizing systemic behaviours replacing catalogued collections of local behaviour. In general, ST describes what happens when investigating which operational configurations of a system as a whole are ascribable to events that are observed as they happen. Figure 2 presents an adaptation of the famous "Iceberg of Systems Thinking" metaphor. It shows how the only way to understand the complexity of the observed behaviour of a system is to analyze the patterns of its configuration, which ultimately depends on its systemic structure.

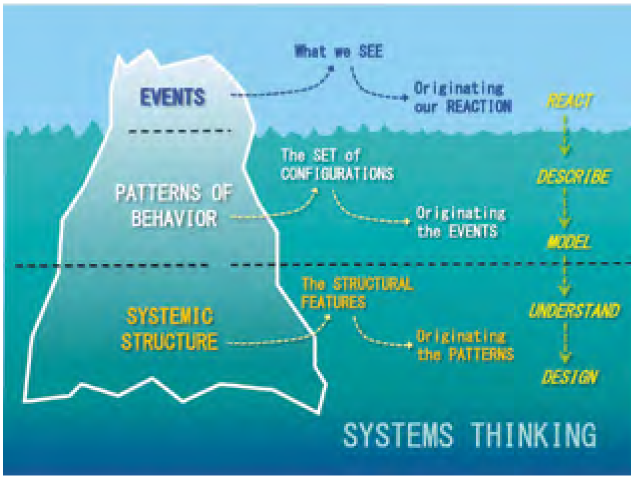

Figure 2. *Iceberg of Systems Thinking*

Systems Thinking might therefore potentially appear to be a mandatory tool at different levels of inquiry, from the description of a system to its understanding, modelling and design. The family of epistemological approaches taking the name of Systems Thinking have developed from the pioneering works of Ludwig von Bertalanffy (1968) and Nicholas Georgescu-Roegen (1971). ST found a quantitative dimension thanks to the work of Jay W. Forrester (1971), which then drew great attention after the publication of "The Limits to Growth", a book that represented an important novelty both for its content and for its epistemological approach (Meadows et al., 1972; Meadows et al., 2004). The general literature on ST has been constantly updated since then (see, for example, Weinberg, 1975; Senge, 1990; Meadows, 2008; Sterman, 2012; Monat & Gannon, 2015), while specific applications have been proposed in several fields. In particular, research groups have started to address systemic approaches to the strongly interconnected patchwork constituted by the United Nations Sustainable Development Goals (for example, Lim et al., 2018; Gómez Martín et al., 2020). Over past decades, a new generation of systemic approaches have branched out, with different names, depending on the perspective and the field of application, ranging from natural and environmental sciences to social sciences, economics and management. Among the most common are, for example, those based on causal loops (Luna-Reyes and Andersen, 2003) and other network-based diagrams (Hanneman, 2011), such as fuzzy cognitive maps (Kosko, 1986), that help identify systemic feedback and delays, but often without providing a diagrammatic architecture suitable for analytical modelling. In quantitative ST frameworks, stock-flow diagrams play a central role.
A system can be described as a set of n extensive variables (stocks) Qi (i=1,...,n) together with the relative inflows and outflows dQ/dt, whose mutual controls set up the feedback network that characterizes the system. Feedback, occurring when a change in a stock affects the flows into and/or out of that same stock, can be direct (a stock influences a flow that in turn influences the same stock) or indirect, when the mutual cause-effect relationship between the changes in flow and stock values follow a path that connects with other stocks. Thus, there may be a feedback hierarchy in the system whenever the respective action is observable over different time scales. Feedback patterns are the feature that defines the dynamics of the system. Even single feedback may give rise to collective behaviours that are virtually unpredictable and very sensitive to small changes in a parameter, as occurs for example in the prey-predator models. Knowledge of feedback structures can therefore address the complexity management, pointing to the proper leverage points for interventions (Meadows, 2008).

The stock-flow model of a system is set up by attributing a proper analytical form to each flow and interaction in any of the processes occurring within the systems, in turn, defined as anything able to alter a flow. A charge-discharge equation is then created for any of the n stocks defining the system state, in the form:

$$dQ_i /dt = (\sum_a J_a^{in} - \sum_b J_b^{out})_i = f(Q_1,\ldots,Q_n)$$

where J_a^{in} and J_b^{out} are the inflows and outflows for the i-th stock, and f is the given function. Stocks and flows are the basis of System Dynamics, as originally termed by Forrester at the System Dynamics Group of the Massachusetts Institute of Technology (MIT). This systemic approach is explicitly devised for computing simulations of system behaviour over time, obtained by finite difference processing of the interlinked differential equations representing the charge-discharge behaviour of the stocks (Sterman, 2000).
Over recent decades, further systemic approaches have been applied to computationally based tools within several fields, following the development of Network Analysis (NA) procedures and the increasing availability of big data. The aim of both perspectives, ST and NA, is to describe a finite system as a whole, yet data-based approaches still retain the microscale level, in so far as they treat a large set of local elements. Nevertheless, the dynamics of those local elements are described on the basis of big data and sophisticated mathematical and statistical tools. Network analysis, agent-based modelling, and causal loop dia-

grams therefore use a complementary perspective to that of ST and may not capture the overall complexity of the system dynamics. Nevertheless, the complementarity of ST and NA presents enormous potential, as pointed out by Bielekova et al. (2014): “The integration of systems thinking with dynamic computational modelling can lead to the development of a ‘virtual sandbox’ in which researchers can utilize their creativity and intuition to try out and explore multiple different hypotheses and lines of investigation”.

The application of ST approaches is nevertheless still relatively limited, due to several factors, among which the most relevant is probably:

> The objective difficulty of mastering both its conceptual and quantitative aspects, which often requires specific training.

> The transdisciplinary nature of its foundations, that prevents the teaching of ST in most Higher Education (HE) academic curricula.

> Pressures within the scientific community to address solutions and applications that are at once feasible, short-term and relatively simple; an option that will depend more on the particular system than the multidisciplinary systems thinker team of scientists.

> Difficulties with communication: in fact, an easy-to-measure list of sustainability indicators will more often attract decision-makers, the mere improvement of which often becomes the actual objective of policy measures.

Needless to say, ST also has a certain relevance when addressing modern instruments for sustainability analysis, such as Life Cycle Assessment (LCA), as well as new integrated concepts. Among these concepts, Emergy (spelt with an “m”) plays a particularly important epistemological role, in so far as it quantitatively addresses systemic sustainability from the donor-side perspective, accounting for all the direct and indirect contributions of the geo-biosphere in the creation of a product or a service (Odum, 1996).

The application of systemic perspectives in the planning and design of urban systems has become ever more relevant in the past few years, especially because of the pivotal role of cities in the undelayable transition towards more sustainable societal and economic structures. Such concepts as urban metabolism, circular economy and smart cities are now keywords for city planning at any level. In this respect, the complexity of both the structure of a city and its link with its supporting region makes systemic thinking compulsory, in so far as flows of resources through a network depend upon a complex and delicate equilibrium, which will ultimately be determined by the systemic features embedded within the feedback networks of the city. Feedback is critical for systems such as cities, where the well-being of its inhabitants is critically dependent upon simultaneous and coordinated operation of all city sectors. The city of the future must exhibit systemic features that will surpass the commonly used indicators of smartness, especially in terms of resilience against disruption, for example, due to extreme weather events foreseen in the context of climate change, and closely related to all urban socio-economic aspects. Events surrounding the ongoing COVID-19 pandemic have clearly demonstrated that cities were all but prepared for an emergency of such proportions. The Global Risk Report 2020 (World Economic Forum, 2020) had previously issued a warning on this point at the end of 2019, reporting that none of the 195 countries under analysis was “fully prepared to handle an epidemic or pandemic.” Although uncorrelated with the overall efficiency of healthcare systems in non-emergency situations, systemic thinking can in that context help to explain why and how even systems with well assessed infrastructures can undergo a dramatic collapse of some vital features.

Unfortunately, current narratives tend to depict cities more as hyperconnected self-sufficient places in the future that wealthy segments of population will inhabit. For example, London is commonly addressed as the smartest metropolis in several worldwide rankings, thanks to its high degree of Information and Communication Technology (ICT) interconnectedness, its level of “creative business making” and its “cultural vibrancy.” But this should be compared with official government data that reports on 700,000 London children living in poverty, and on the growth rate of 15 new homeless per day in 2018 (London Datastore, https://data.london.gov.uk; CHAIN multi-agency database, https://www.mungos.org/combined-homelessness-and-information-network/). Interconnectedness means that medical data may be accessed from home, thereby reducing the environmental traffic load, although this situation assumes the existence of efficient sanitary service, an internet connection, and -of course- a home. Current smart city narratives also neglect the links of the city with its support region, that provides the necessary resources and whose prosperity depends in turn on the city activity (Gonella, 2019). In this respect, systems scientists warn of what is known as "shifting the burden", an archetypical lack of systemic awareness that identifies and fixes problems through external indicators of a malfunction, an approach that is by definition contrary to the very essence of systemic thought. Indeed, the study of sustainability at different scales is mandatory for any integrated sustainability assessment. From the systems thinking point of view, a system must be studied by subsequent enlargements of its systemic boundary, so that criticalities and possible leverage points may be detected within it.

An ST approach to city sustainability studies could be exemplified through one of the most commonly addressed urban issues: traffic pollution. Following a conventional linear non-systemic description, pollution due to traffic emissions may be ascribed to various causes, each separately treatable through linear cause-effect chains that should permit "local" interventions to interrupt the various chains of events. A possible list of these causes might be:

> High numbers of vehicles;
> Use of vehicles with high-emissions;
> Lack of infrastructure that causes congestion and traffic jams;
> Lack of public transportation options;
> ICT interconnectedness to reduce unnecessary travel.

Several solutions have in turn been separately addressed for each of these points, among which is the building of further road networks, the empowerment of public transportation, the creation of bicycle lanes, the activation of car-sharing programmes and, more recently, incentives to use electric vehicles, as well as the development of ICT interconnectedness to limit unnecessary travel. Though locally and episodically effective, the general efficacy of these measures has largely been overestimated.

Let us take for example the empowerment of road networks. This urban policy has always been accompanied by increased traffic loads. It is an example of the well-known Jevons paradox, according to which more efficient access to a resource (in this case, mobility) will increase consumption of the resource until the former (or an even worse) level of inefficiency is reached. A systemic effect (overall mobility adaptation to the new infrastructural network) in this case hampers any beneficial effects, as the systems rearrange themselves to maximize resource exploitation.

With regard to the empowerment of public transport in Tokyo, the underground train network is so extended, reliable and efficient that many public transport users have no wish to pass a driving test. But in many metropolitan areas of Tokyo, the extremely low levels of interpersonal crime and micro-criminality mean that people feel safe using public transport at levels that are unrivalled within many other large urbanized cities throughout the world.

Empowerment of public transportation networks merely by expanding to the number of buses and their schedules will generally be ineffective when the complexity social problems is not taken into account alongside infrastructural issues.

Another example is the use of electric vehicles. Increasing sales of electric vehicles, sharply promoted by the interest of automobile industries in new market niches as well as by the possibility of offering a "greener" image, has originated an interesting debate on the real degree of sustainability that this technology can offer. In particular, it is questioned whether electric vehicles could just "shift the [unstainability] burden" of traffic pollution. The electrical energy that drives a vehicle requires energy of a different kind, unlike fuel, the sustainability of which should in turn be supervised and controlled, otherwise the environmental problems of the city system will simply be "externalized", solving a problem in the here and now, without taking stock of its impacts within other areas.

Systemic approaches start from a different perspective. First of all, any specific problem is framed within an accurate and comprehensive definition of the complex network of resource flows that constitute the urban metabolism function. Traffic emissions are just one aspect of this metabolism and cannot be treated, *per se,* as a separate problem. Traffic is the expression of specific flows of food, goods, machinery, labour and services (in the form of people) crossing the city boundary and within the city itself. Once there is a general picture of the flows that define a functional city and their mutual relationships in terms of their feedback network, a semi-quantitative simulator can be set up, capable of revealing the tendency of the system towards self-adjustment and rearrangement following a modification of one or more of its sectors. Then, effective systemic leverage points can be sought, by analyzing how the entire system might react in both the short and the long term.

Effective leverage is often only found by studying and viewing the system from a wider perspective. From this perspective, ICT interconnectedness and public transportation will perhaps not play a major role as leverage points. Instead, primary systemic leverage is a possible change in the role car and oil industries play in the definitions of the national and local policies. Too often, cities look like they are made for cars, not for citizens. In so far as policies must first be aimed at maintaining city mobility or even making it easier, so too must the negative systemic consequences be addressed of having tens of thousands of vehicles in circulation every day. ST analysis tells us that fighting against pollution without addressing any change in the local economy is a lost battle. We expect that the nexus between environment, health and food production and distribution plays the major role, in as much, it determines the need for transportation and mobility and the resulting mobility within the urban area.

Climatic, Ecological and Eco-Economic literacy, the fundamental basis for the mandatory shift in paradigm that the global threats present at city scale, should first be addressed. The use of systemic tools for city planning is no easy task. It requires a deep knowledge of all the mechanisms of urban life and the capability of putting them together in a comprehensive analytical picture. On the other hand, the potential of this approach should be evident, as far as the solutions to complex problems are expected to be complex as well. Fortunately, in the case of cities, these approaches require strong interdisciplinarity. Architects, environmental scientists, town planners, policymakers, sociologists and mathematicians are all needed to address urban and city problems from a multi-disciplinary systemic point of view that offers the keys for a real sustainability assessment of a modern city.

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Credits: Eurac Research

1. Interactions

Aerial view of the Qunli National Urban Wetland (China), *Photo by Sara Daneshmand*

1.1

Human. Nature. Built Environment.

Scale Jumping Nexus

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Summary and Scale Jumping

In this chapter we explore the nexus of Nature, Human and the Built Environment and how combined they shape and define the mindset required for regeneretive sustainability. Importantly it demonstrates how rethinging sustainability must lead to regenerative economics, the central aspect of RESTORE. This chapter is based upon a number of patterns, developred throughout the short life of the working group, as the ciritical areas deemed necessary to scale jump from sustainability as usual (BAU) to Restortives Sustainability and on to Regenerative Sustsinability.

Adressing Scale Jumping

For the purpose of this chapter we will address Scale Jumping as *the transition from a sustainable built environment to one that is regenerative and enables life to thrive. This is the definition first appeared in the Cost Restore Working Group One, Faro Papers. A definition that is built upon within this chapter and will be of interest for anyone within the built environment concerned with scale jumping to a truly regenerative future that is socially just, ecologically sound and culturally rich.*

1 Introduction

By Martin Brown

> A thing is right when it tends to preserve the integrity, stability, and beauty of the biotic community. It is wrong when it tends otherwise.
>
> (Leopold A, 1949)

Regenerative thinking, the Seva mindset promoted through RESTORE, is focused on developing capacity and capability for systems evolution. It is not about sustainability that maintains what is, or attempting to restore something to what it was by only reducing impacts. Rather, it is about creating systems (places, buildings, communities, organizations) that have the capacity to evolve toward states of health that thrive over time. The first four RESTORE working groups and their publications, papers and outputs have demonstrated that we have the tools, the metrics, the approaches and the solutions for a symbiotic Human Nature Built Environment relationship (Cost Restore, 2020). What we arguably lack in our mindset is the jump in scale that is to be applied. The mindset scale jump to where nature is seen as both a stakeholder and mentor is for some a big scale jump, but one of necessity. The degenerative discourse and path we are on is too dominant. (Brown, 2021)

SEVA

"The planet does not want to be saved. Or rescued. Or even changed. Our planet wants to be loved. Love is not a game of numbers and spreadsheets, checks and balances, debts and contracts. It is an exalted dance of joy, respect and gleeful, mutual appreciation and true partnership" Ed Gillespie 'The End of saving the world' (Gillespie, 2020).

What this chapter will demonstrate, through a collection of perspective papers, articles and thoughtful pieces from WG5 SubTask "Human-Nature-Built Environment" members that explore new or unique viewpoints, is how new regenerative paradigms can be applied, not to be in competition or opposition to the current paradigms, but to be so obvious, so rewarding and effective that the old ways of doing things becomes redundant. Within the context of buildings and cities we pull on definitions from Working Group One and in particular, to scale jump the regenerative buildings definition, as the key concept for the human, nature and built environment nexus, that **regenerative buildings exist to enable all life to thrive.**

Behaviour theory notes that for change and tipping points to occur, we need to reset the conditions to enable the regenerative paradigm to become easy, common place and rewarding. To do so, RESTORE work has to date set out tools, methodologies and approaches; their effective application within this process is vital.

RESTORD 2030 What if a city became truly regenerative …

RESTORD is a small to medium-size seaboard city, at the foot of the Central Mountains with a Mid-Euopean climate. It has a population of 102,000. Its city politicians, planners and officials adopted an approach inspired by the work of the EU Cost Action RESTORE and the publications from the 5 working groups. It embraced the regenerative principles and definitions, mandated regenerative design, construction, facility operation and technologies and scale jumped into an exemplary regenerative city

RESTORD 2030 is founded on the patterns that now govern development and infrastructure. The patterns, known as 'leaves' represent the growth and health of the city, they are system thinking based and fractal, each complementing and supporting other patterns, never limiting or overshadowing other patterns and they emerge organically. In this chapter, the vital patterns of Human, Place and Space, Design, Energy, Materials, Education, Equity and Economics are described.

When considering the human, nature and built-environment nexus, there are approaches and techniques available to us, based on a deeper understanding of and learning from nature. The following alternatives are explored throughout this chapter from differing perspectives on the patterns, considering core-to-scale jumping of our connectivity with nature:

> **Biomimicry** - creating solutions to human challenges by emulating designs and ideas found in nature. (Beynus, 2016)

> **Biophilia** - Biophilia is the passionate love of life and of all that is alive (Fromm, 1973, p.365).

> **Biophilic Design** - bringing the experience of nature and life into designs (Brown, Sturgeon and Bochart, 2020).

"Learning about the natural world is one thing. Learning from the natural world — that's the switch. That's the profound switch."

(Benyus, 2016)

There is much research, writing and data, in the disciplines of health, psychology, sociology and the built environment to show that scale jumping on biomimicry and particularly through biophilic interventions can lead to improved human health, wellbeing and social interactions. And, as explored in Terrapin Bright Green's report, The Economics of Biophilia, (TerrapinBrightGreen, 2015) there is a compelling financial argument for designing with nature in mind. The Living Building Challenge (ILFI) remains the only regenerative building standard that includes mandatory Biophilic Design workshops that at the start of a project. It has developed a range of Biophilic Design support guidelines and toolkits.

2 Human Pattern

By Martin Brown, Ana Sánchez-Ostiz, Haris Gekić, Zvi Weinstein, Madalena Sbarcea, Doriana Matraku Dervishi

Introduction / Narrative

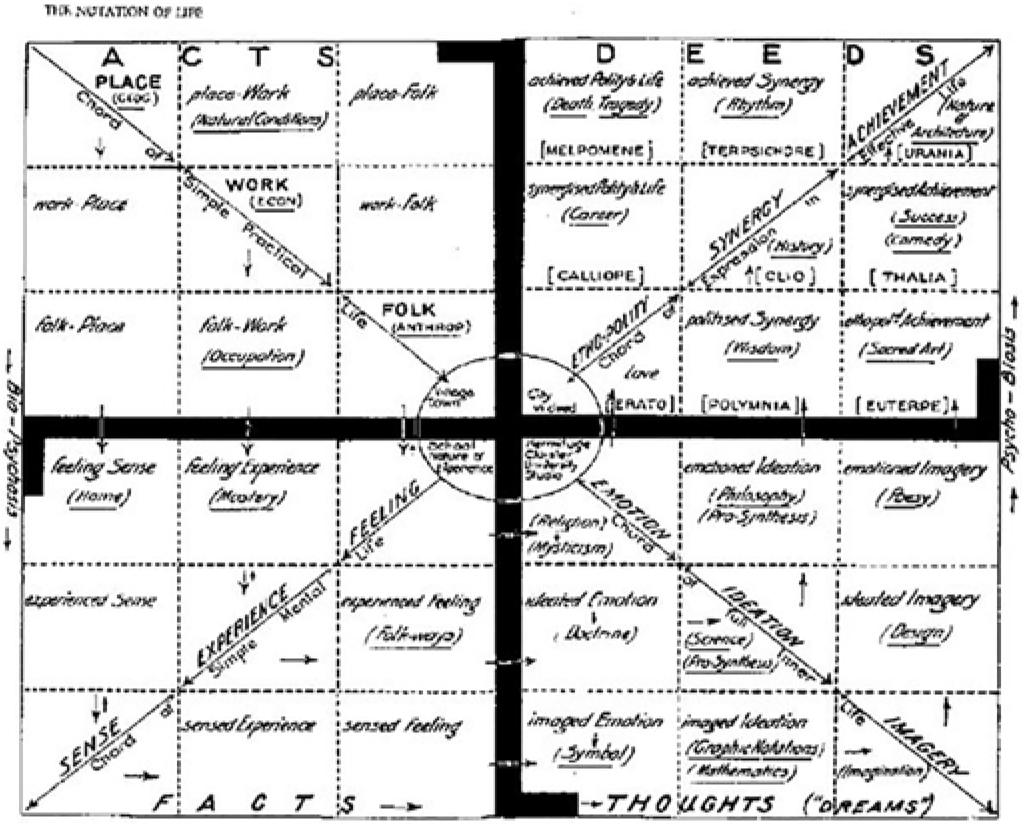
> The environment and sustainability is used to describe everything beyond the human sphere, as if there was a set of hard and fast barriers with us on the one side and "the rest of life on Earth" on the other.
>
> (Porritt, 2004)

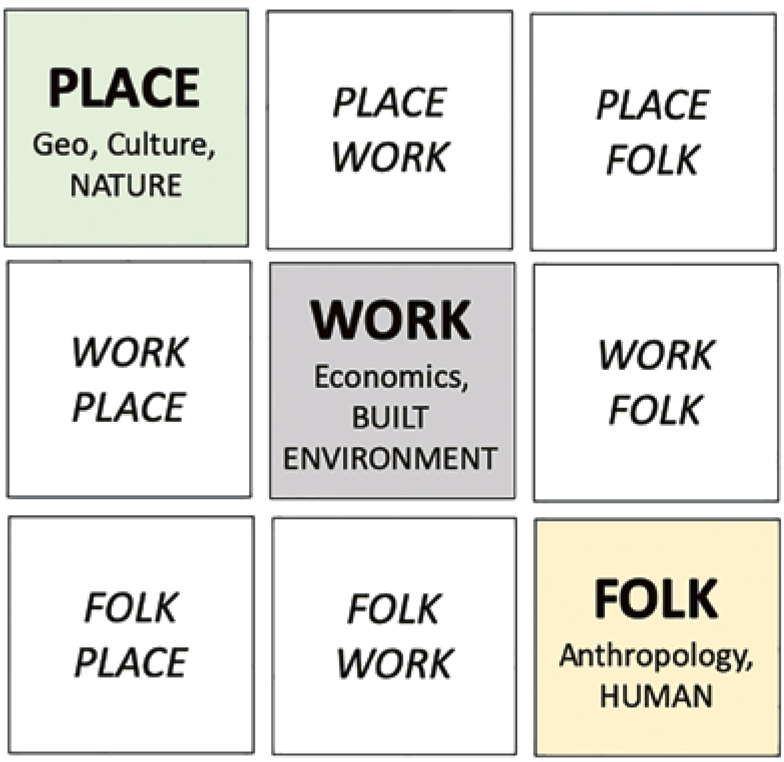
It is well established that we are now within the Anthropocene era where the impact of humans on the planet is the dominant ecological issue. We would also see this as our eco age, yet despite 30+ years of sustainability and environmental focus we have not managed, contained or reversed the human negative impacts on our planetary eco systems. Over this period, our approach to sustainability has scaled up to embrace thrivability and moving into regenerative and reciprocity paradigms, giving back as much if not more than we take. However, if we are to really scale jump forward, we now more than ever need (anthropologists would comment from an indigenous culture perspective, once again) to understand our role and our responsibility within ecosystems, in so far at we are integral human agents within nature, not a species divorced from nature. And not only must we understand ourselves as humans, but the technology that we produce and use must also be understood (and more importantly developed) as an integral part of nature, rather than outside it.

It was Winston Churchill who famously said we shape our buildings and our buildings shape us. However, this was a zeitgeist statement of its time, and it no longer holds true. It is nature and eco- systems that will shape us and our built environment, our wellbeing and happiness, our cultures and spirituality, productivity and thrivability as we work, play and live in our structures.

From a deep-time perspective, we need to be asking ourselves whether we are good ancestors, what will future archaeologists and anthropologists make of our built environment in its robustness, purpose and impact when unearthed in a future time. Driving the relationship between ourselves and our built environments is the human construct of economics. Yet (Sanford, 2020) even the word eco-nomics is derived from management of the home, and if we see our home as the earth's ecosystem, then we can shift, even scale-jump economics from its function as a controlling restraint on regenerative buildings and cities to one that supports, underpins and encourages their proliferation.

Our cities are founded and evolve around the human, nature and built environment nexus (place, geo). And will like any system evolve, without intervention, based on the flows of resources and energy to and from





With Geddes, Local to Global thinking 'PLACE' starts with the local ground on which we stand and moves out into communities, regions and global.

Figure 1.1.1. *Place, Work Folk, (After P Geddes, Cities in Evolution (1915)*

the local and global environments. The success of urban planners, city officials and mayors (for example Curitiba Brazil where radical ideas created Brazil's 'green capital' (Guardian 2016) is precisely that they have understood the scale-jump interventions, the leverage points and the acupuncture points.

A historical precedent can be found in the work of Sir Patrick Geddes (1854-1932), a systematic, holistic thinker, biologist, sociologist, geographer, philanthropist and pioneering town planner. His understanding of this relationship as the nexus of place, work and folk, aimed at protecting, celebrating life and its evolutionary possibilities was in agreement with Ruskin's: "There is no wealth but Life". They both believed that one can only make sense of things by seeing them as parts of a bigger system.

Geddes elaborated ideas (Fig. 1.1.1) throughout his lifetime in such a way that they became the philosophical touchstone on which so much of work on environment and culture is based. This thinking is central to contemporary debate and research into regionalism and locality, economic and community regeneration, environmental quality and sustainable development, and social inclusion. "It is interesting to consider the way in which "place, work, folk" matches up with the current, rather emaciated, versions of the triple bottom line – environment, economy and society or people, planet and profits" (Alexander, 2006).

Scale Jumping Actions

1. Bio-Leadership

Throughout the patterns that may be perceived within this chapter, we will see a focus on connectivity with nature, on shifting our design paradigms, so that our buildings become part of nature, and do not stand apart from it, and on improving the physical and mental health of building and city inhabitants through biophilic and salutogenic interventions. However, our leadership style remains stuck in a mechanistic mindset. If we are to embrace nature-based solutions, we need to embrace nature-based leadership, with bio-leadership, to ensure we make it there and to ensure regenerative places, cities and buildings. Built-environment leadership needs to scale jump, in language and in actions, to bio-leadership (Roberts 2020)

> "Our world is dimensional, whole, alive, and contin-uously evolving, but our inherent capacity to under-stand it in these terms has mostly been trained out of us in favour of analytic methods that dissect, com-partmentalize and lineate".
>
> (Sanford, 2020)

1. Thinking: Applying rules of nature to human systems;
2. Feeling: Cultivating a different set of qualities internally;
3. Connecting: Working together to weave a new culture of progress into the world.

This resonates well with the regenerative leadership approach from the likes of the Regenesis Group's Regenerative Practitioner.

2. Regenerative Mindsets (Plaut and Amedée, 2018)

Systems actualizer: the aim of a regenerative practitioner is to become a 'systems actualizer' – to help realize the unique value-adding the potential of a place, an organization, and/or an ecosystem.
Framework thinking: adept use of frameworks helps to bring ordered thinking, and a capability to act effectively within complex systems.
Self-actualizing: the ongoing ability to develop capacity and capability within yourself is essential for participating in regenerative development work.
Developmental facilitating: a dynamic and adaptive process for guiding groups towards their sense of purpose and their ability to achieve their full potential together.
Living systems: understanding these systems enables us to see where and how to engage, based on the principles of life.

3 Design Pattern

By Martin Brown, Jelena Brajković

> In The New Wilderness, penthouses, lawns and swimming pools don't exist any more because they take up too much precious space, over-population means everybody is crammed into high-rise blocks in the City. No one goes outside except to go from building to building. The City, with its extreme pollution, is toxic to children. Citizens cannot travel outside the City, nor would they want to, and they count themselves lucky if they live near one of 10 gated trees, left over from a time when humanity lived more harmoniously with nature.
> Lands outside the City, such as the Manufacturing Zone, the Mines and the Server Farms, have been requisitioned to serve the City's needs. In this dystopian version of the US, the only state that has escaped the utilitarian drive is the Wilderness State, a rewilded refuge for flora and fauna where humans aren't allowed.
>
> The New Wilderness, Diane Cook (Guardian 2020)

Why in 2020 do we delight in life outside of our buildings when the focus of sustainable design, at least over the past decade, has been to create sustainable, healthy spaces for living, working and playing that are far more aligned with the natural environment? Yet alongside the sustainability agenda, our drive is for more growth in the built environment, with bigger, taller, smarter and fancier boxes with hard surfaces, composed of toxic materials and communication/wifi/5g signals that increasingly disconnect us from the earth and ecosystems.

Are we aware of the influence of the technology in shaping not only our built environment but also our everyday lives, habits and mood? Are we aware of the mediation? Can we see biophilia within technology? When we discuss the design of the built environment, we must acknowledge the design of technologies that we embed in environments (not only urban) as one of its most important elements. We must guide our technological future and shape the technological development in a way that they can bring us back to nature (Ascott, 2003).

New Media and Biophilic Design in Space

If we discuss design discourse, the most important scale-jumping discussions must include questions of biophilic guidance on the creation and the use of technologies and media in space. After industrial (machines replacing humans in performing automotive work) and far more powerful digital and computer revolutions (machines used for communication and control), through the rise of machines, we have irreversibly changed our relationship with nature, or as Roy Ascott expresses it "God-given nature" (Ascott, 2003, 328). Some aspects of transhumanism and cybernetics can be seen as biophilic, as they deal with our perception and need of nature, and designing of relationships between artificial and natural systems. Biophilic design should adopt the fact that technologies form an integral part of nature, rather than opposing it. This nature is of course new, Neonature, Nature II, "a new creativity" whose "engines of creation (Drexler, 1986) will embrace artificial life" (Ascott, 2003, 330).

If we adopt this standpoint, we must start developing biophilic discourse around it. We should carefully guide, monitor and design the development and the use of technologies in space, as they hold great potential. Some of their potential and goals, as well as transhumanism as a philosophy, have even been compared to religion, as they fulfil "some of the same functions as a religion without any appeal to a higher power, a supernatural entity, to faith and without the other core features of religions (More, 1990). The central place accorded to rationalism suggests a tension between transhumanism and religion. But are they actually incompatible?" (More, 2013, 8). Indeed, modern technologies can produce spiritual and poetic effects, and fairy-tail like results. *Troika refers to new media art and environments as fairy-tales for adults (Freyer, Noel & Rucki, 2010). However paradoxical it might appear, we should understand new media as a portal, a new "open doorway into the natural world" (Ascott, 2003, 328). However, each step should be carefully taken, as* "the same powerful technologies that can transform human nature for the better could also be used in ways that, intentionally or unintentionally, cause direct damage or more subtly undermine our lives" (More, 2013, 4).

As said before, if we discuss design of the built environment, we must acknowledge, and be aware of technologies as a design factor. They have already altered many features of the environments we inhabit. As said in Introduction for this book, as Rachel Armstrong noticed, society in the 21st century is less determined by objects and increasingly shaped by connectivity (Armstrong, 2013). With networks and high technologies as parts of the environment, as Ascott observed, there is no more binary opposition between town and country, urban and rural... Ascott even referred to connectivity as a new principle of life, an evolutionary stage in human development (Ascott, 2003). Networked environments enabled us to live *glocally* (Armstrong, 2013). Within connectivity as a principle of life, we can identify many advantages, but also disadvantages (always-on society, anxiety, pressure, and information overload...). Through the scale-jumping approach, we should develop principles and attributes, both for biophilic use of technologies and biophilic lifestyle, limit the presence of networks, shape the way we use it, and design mediation of technology in a biophilic way. We should be inspired by the emergence of practices that are developing biophilic approaches towards the use of technologies in space. These practices promote biophilic uses of technologies, as a way of respecting, promoting and (re)connecting with nature.

> "DRIFT's work has always been about creating meaningful connections with our natural environment by working with contemporary technology... To restart life after the virus changes are in order. We are

getting a chance to rediscover the values and happiness of a more simple life. The virus will help us to focus on technology that will support this. Never before has there been a time for nature, humankind and technology to be more in sync … to stand united and to focus on a sustainable technological supported reconnected future." (Nauta/studio.drift, 2020).

Built Environment – a Climate Crisis Problem

Against the now dominant landscape of the climate and ecological emergencies, our built environments continue to escalate the crisis, adding more carbon, creating further health issues and increasing our disconnectivity with nature, with only a small proportion of sustainable buildings yielding significantly reduced impacts and a sprinkling of buildings that are regenerative and making a contribution to the climate and ecological solutions.

A significant volume of buildings, homes or offices, where we spend 90% of time, have been designed with no consideration for our innate and necessary connectivity with nature, and in doing so nulls rather than stimulates the mind and our health systems. A significant number of spaces could be considered unstimulating, with many spatial features that could be improved.

Is this so and, if not, what is the ambition of architecture and design?

Architecture as Spatial Media - Designing Experience of Space

Through scale jumping and systems thinking, we must extend understanding of architecture from its physical manifestations to its mediating properties. As Pallasmaa, 2018, points out from the perspective of the meaning of space and the relationship between human condition and place, what is architecture if not spatial media? And not only spatial, but also temporal. "Architecture materializes history and mediates our relationship with both space and time; we dwell both in space and time, and architecture needs to "tame" both dimensions for us. I see this mediating task of architecture as more important than any subjective artistic expression" (Pallasmaa, 2018, 2). In the process of designing, creating environments, mediating tasks of architecture should be our highest priority.

Built Environment - a Climate Crisis Solution

Scale jumping our current approach to regenerative design over the next 10 years will undoubtedly see a significant shift, driven by a number of converging innovations and improved understanding, within and without the built environment. Predominantly, buildings impact on our health, decarbonization, the relationships of our buildings with natural ecosystems and innovations in material science. And, of course, the 2020 Corona Virus crisis and Black Lives Matter movement have changed design with respect to social and just interactions. Our built environment designs remain predominantly based on right angles, angles that are never found in nature, and indeed both ancient, indigenous cultures and current research have demonstrated that bio-geometry has a profoundly beneficial impact on our wellbeing.

In Scale-Jumping regenerative Living Buildings, we must change the question, from "What if that happens?" to "What is happening?". In 2020, we asked what good actually looks like, we now need to declare that this IS what good looks like. From asking Would it not be wonderful, if all buildings were living buildings? to, asking Why aren't all buildings living buildings?

Could bio-based, bio-geometrical buildings provide the scale jump catalyst as a new regenerative purpose for built environment design? Through regenerative bio-hacking, (the deep dive understanding of our environment and the reciprocity between buildings and eco systems), we can arrive at a new purpose for the buildings we design and create, and wish that the ecosystem will have a harmonious impact both on our biology and on the biology of nature.

We can and we are now revisiting those ancient cultures and design through a modern lens, whilst waking up to and learning from the relationship of indigenous cultures with the natural environment, through place, and then through deep time. The reciprocity between buildings and nature entails the distribution of equity to building owners, inhabitants, other affected parties and to nature. Place and natural features both have recognized 'personhood rights'. Personhood rights (as granted to rivers, land and natural features in New Zealand) ensure that nature has a voice through custodial representation, switching from evaluating impact to the bequeathment of equity. A new and real voice at the design planning table.
Our buildings and urban environments continue to be based on compromise, whereas nature has no compromise, and thrives on constant harmonization. Scale jumping from one bio-based building to a district, town or city can enable a bio-focused approach to positioning buildings and their harmonization as part of an urban planning strategy.

Experimental Design Strategies

Within architectural discourse, experimental approaches, whether theoretical or practical, are appearing, that are trying to scale-jump and reimagine not only the understanding of what architectural space is, but also what architectural interventions could be, and how space can *behave* and interact. Meteorological architecture, morphogenetic design, morpho-ecological design, biomimicry, neoplasmatic design, protocell architecture, proto-achitecture, narrative architecture, transgressive architecture, archtextiles, energies as materials… are just some of the directions that steer the path away from mainstream architectural discourse. Readers of this book interested in experimental design strategies may well find John Wiley & Sons' *Architectural Design* Journal Series a source of inspiration and information for scale jumping strategies and bold approaches to architectural design, as it is committed to grasping the frontiers of architectural research. If we want to scale jump in designing urban environments and architectural sites, we need to rethink the notion of architecture itself, as well as the scale we associate with it. Territories and boundaries between different design categories (as well as science, technology and arts) are becoming more blurred and hybrid each day, which enables us to reimagine ways in which humans, nature and the built environment can connect within a triangular matrix.

4 Place and Space Pattern

By Ivan Šulc, Ana Sánchez-Ostiz, Haris Gekić, Jelena Brajković

The **concept of place** refers to a special combination of the unique physical and human characteristics of a location, ranging from tangible, visible and easily identifiable (*e.g.*, terrain, climate, waters, vegetation, population) characteristics to those that are intangible and felt (*e.g.*, culture, sense of place, comfort). It is used on different levels and scales – from a single site (*e.g.*, building), building block, neighbourhood to whole settlements, cities, urban regions and wider. Here we present several elements of urban places that address the human, nature and built environment nexus, reflected in land use (*e.g.*, residential zones, industry, tourism, recreation), transport and mobility, place comfort and sense of place (Fig. 1.1.2).

Post-industrial European cities are challenged by urban expansion, which leads not only to irrational land use, but also to negative impacts on the environment, society and the economy (Laprise *et al.*, 2015). To deal with these consequences, inward development of the city must be carried out. The aim is to encourage **higher density and better accessibility**, while moving towards a compact, polycentric city model (Williams *et al.*, 2000). It is also important that, in the context of sustainable densification of cities, the rehabilitation of old buildings is more sustainable than the construction of new buildings on the periphery, which consume a lot of natural land and increase the need for transport. **Regeneration of disused urban areas** also offers significant potential for land reclamation. In fact, these projects can simultaneously contribute to the densification and revitalisation of existing built up areas (Laprise *et al.*, 2015).

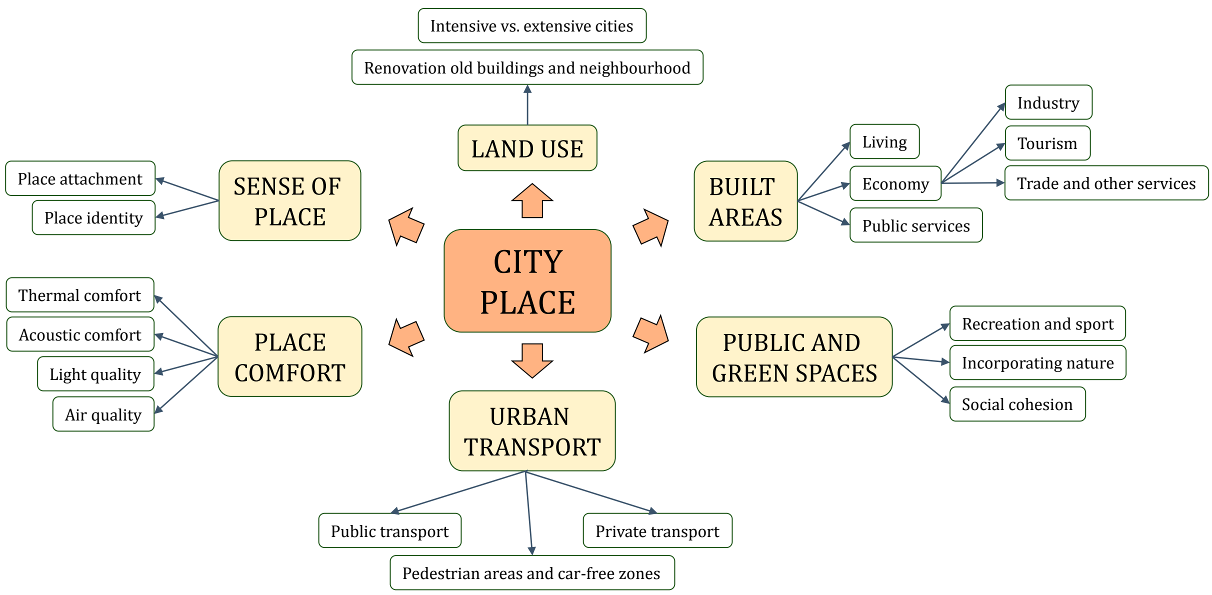


Figure 1.1.2. *Elements of place in regenerative cities.*

Built areas in cities have various functions, ranging from private to public, from residential to business, industrial or public services (e.g., schools, hospitals, theatres, sports halls) etc. Many cities have based their existence upon industry as their main urban economic activity. Due to changing location factors and global trends of moving most old industries to the Global South, industry has left its mark within urban centres and former industrial zones and around the periphery. In the process of urban regeneration these former industrial buildings and blocks are re-used either as heritage or are torn down and redeveloped. However, the flexible production systems of a post-Fordist economy and the technological innovation postulated as a basis for the fifth Kondratieff upswing come together in particular places or **new industrial spaces**, particularly in developed countries, variously referred to as technology parks, science cities and techno poles. At the intra-metropolitan scale new industrial clusters centred on innovative, knowledge-based, technologically intensive activities such as computer graphics and imaging, software design and multimedia industries as well as technologically *retooled* industries such as architecture and graphic design have been identified as key components of an emerging *new economy* of the inner city. Such firms are attracted to the metropolitan core by the creative habitat, potential for *knowledge spill-overs* between companies, opportunities for social interactions across work and non-work life, and the cultural and environmental amenities of the locale (Pacione, 2009).

Globally, ***Hsinchu Science Park,*** one of the most important, was opened in 1980 in Hsinchu City, NW Taiwan. It covers six locations with a total area of 6.5 km^2 and mainly houses semiconductor and optoelectronics ventures. More than 520 tenant companies employ more than 150,000 people. At least 50 of them have emerged as spinoffs from the nearby Industrial Technology Research Institute, Tsing Hua National University and Chiao Tung National University. Around 40% of the total workforce is devoted to R&D and technology development, with the remaining 60% taken by people engaged in production, management, marketing, etc. In terms of educational levels, around 79% of HSP employees have junior college or higher degrees, which compares with only 18% registered within all of Taiwan's manufacturing sector. That small piece of land comprising only 0.04% of the surface area of Taiwan is responsible for initiating over 70% of global IT industry products (HSPB, 2020). One of HSP's main companies and one of Taiwan's largest is the Taiwan Semiconductor Manufacturing Company Ltd. (TSMC) (Fig. 1.1.3).

Figure 1.1.3. *Taiwan Semiconductor Manufacturing Company, Limited.*
(Source: Hsinchu Science Park, 2020 Creative Commons)

New production patterns and expanding global urban populations emphasize a **residential function** that occupies some of the highest proportions of built areas within cities. Social topographies of world cities are largely different, ranging from cities struggling with large squatter communities with a less than minimum quality of life, to high-tech and smart cities focused on planning residential areas for upmarket and high-price housing market segments. A great challenge for each city and neighbourhood is to develop an identity able to provide residents with a home of their own (Hassler, 2016).

An excellent example of a regenerative urban area is a private residential ***ecoQuartier Pfaffenhofen*** completed in 2014, in the town Pfaffenhofen an der Ilm, north of Munich, Germany. The zone includes 217,000 m^2 gross development land and 50,200 m^2 net housing area (Ecoquartier, 2020). Neighbourhood facilities, such as a community house and a camping site, were also developed in the process of engagement with neighbourhood residents. The ambitious energy plan aims to achieve massive CO_2 savings. Heating and hot water are generated from regenerative energy sources. A local heating network connected to a biomass Combined Heat and Power (CHP) plant supplies power to most of the residential buildings. All roofs have to be equipped with photovoltaic systems to supplement electricity generated at the CHP plant, by providing a significant share of the neighbourhood's electricity from renewable sources. Planners also required a higher energy standard for the buildings, in excess of statutory requirements. The primary energy demand of the buildings must not exceed 70 kWh/m^2a, while specific heat-loss transmissions must be at least 15 percent below ENEV 2009 values (Bott *et al.*, 2019). The private-sector ecoQuartier in Pfaffenhofen aims to demonstrate how sustainable urban development can meet high standards in terms of protecting resources and climate, as well as social aspects for the life of their inhabitants

In recent times, residential functions and the regeneration of former industrial areas are increasingly integrated with **urban tourism**, which has recorded very high growth rates, associated with low cost flights, multiple short holidays during the year, growing interest for culture and global internet platforms for booking accommodation. Tourism creates jobs for local people and raises their income, promotes cultural understanding between hosts and guests and provides financial sources for protecting, promoting and restoring cultural heritage (Šulc *et al.*, 2020). It can also foster the regeneration of decayed buildings or neighbourhoods (*e.g.*, by converting them into hotels or adding new social activities) and it can encourage better planning and maintenance of cities (or at least their central areas). However, ever larger numbers of cities live with the negative impacts of tourism, generated by inadequate planning or *overtourism*. Uncontrolled touristic development tends to place city centres and heritage sites under high pressure, by overcrowding them with people, changing the structure of businesses in favour of tourists, increasing real-estate prices that become unattainable for housing locals and increasing socio-economic inequalities among the urban population. *Commodified* heritage is used primarily for entertaining tourists; city centres lose their character as places for living and working and become open-air museums, while the urban life moves towards the periphery.

At the same time, social relations in Western countries are weakening due to increasing urbanization, disconnection from the natural environment, individualism and dependence on technologies (Kingsley *et al.*, 2020). Urban development and planning should consider the construction and maintenance of **public urban green spaces** as they are crucial to the well-being of citizens and are an important part of everyday life in cities (Campagnaro *et al.*, 2020). In addition to the environmental benefits (reduced natural land consumption, reduced pollution and heat-island effect), the use of these areas means an improvement in people's health: lower mortality and better mental health (Cole *et al.*, 2019) and even reduces cardiovascular risk factors and diabetes (Tamosiunas *et al.*, 2014). The design of **public spaces** and community gardens have been identified as promoting social inclusion, interaction and social cohesion (Kingsley *et al.*, 2019). The term green space includes urban parks, gardens, forests and/or agricultural land (Cole *et al.*, 2019).

Another alternative for the incorporation of green areas into the urban fabric is the use of building roofs as orchards or gardens. One of the perceived benefits of these gardens is the enjoyment and possibility of

opportunities for children's play and retreat for quiet moments in the midst of dense urbanity (Yuen and Hien, 2005). Another benefit is the reduction of heat-island effects and energy consumption. A study conducted in Singapore showed that installing this type of garden on the roof of five-story commercial buildings could provide savings of 0.6-14.5% in annual energy consumption (Wong *et al*., 2003). It is also necessary to maintain and to preserve **natural waterways**, because they contribute to the well-being of people and public health in a similar way to green spaces (Haeffner *et al*., 2017). Public green areas in cities are mainly used for **recreation**. Their location and purpose have to be carefully planned from the neighbourhood to the urban-region level to meet basic human needs and to provide the above-mentioned benefits.
Sport is a particularly important recreation activity that requires large open spaces and specialized buildings. Planning a sports facility requires the consideration of different conditions – sport size and topology, position in the city, relationship with public space, visibility, distance and proximity, accessibility, public access and flexibility (Valle and Kompier, 2013). The requirements of the sport for which the building is designed form the starting point of the design process (*e.g.*, dimensions established by sports federations, type of sports field, material on the ground etc.). Major sports complexes attract many people at different times, so their functions may be combined with those of restaurants, shops, hotels and music venues. These complexes eventually become major recreation hubs in the city that attract multiple audiences and social places where people can meet up (Valle and Kompier, 2013). A good case of a smart sports complex is the **Vodafone Park in Istanbul**, home of Beşiktaş JK with 44,000 seats, opened in 2016. Beside the most modern technology, it includes an entertainment and fashion centre that hosts numerous concerts and fashion shows by famous artists and dress designers during the year.
Cities require quality integrated **urban transport**, to ensure that all urban systems function properly. City authorities and urban planners tend to promote public transport, walking and cycling, as alternatives to counter the increased numbers of private vehicles, traffic congestion, lack of parking, long commuting journeys, air pollution and noise. Depending on the size of city and its characteristics, various modes of transport have been developed (metro, suburban trains, trams, buses), with special attention focused on the reduction of air pollution through the use of electric vehicles and buses that run on biofuels and gas (see Šulc *et al*., 2020). Parking is displaced from city centres towards the periphery by introducing the *park & ride* system. At the same time, cars are discouraged from entering the inner city through prohibitions, taxes, entrance fees, a small number of high tariff parking places, bans on old and high pollution vehicles (*e.g.*, diesel cars and trucks), crowds of people etc. (a good example of efficient transportation systems may be found in Milan, Italy). People are encouraged to walk or to ride a bike in the cities, by enlarging car-free zones, widening bike lanes, which brings health benefits, reduces traffic congestion (even at peak hours) and improves air quality. Therefore, special attention has to be given to the design of **pathways and pedestrian areas** through proactive policies to improve alternatives for moving and walking (Guo and Loo, 2013). One study (Cui, 2020) suggested the use of elevated and underground pedestrian networks within certain cities, so as to offer alternatives to street-level pedestrian sidewalks. The design of the pedestrian environment must also ensure that places and spaces are accessible and comfortable for all.
Overall comfort in the city refers to adequate **outdoor environmental conditions** that comprise thermal comfort, acoustic comfort, light quality and air quality. Outdoor **thermal comfort** is easily perceived and directly affects the quality of urban life. In cold climates, proper design of the width of streets and squares according to the height of the buildings can guarantee sunshine and at the same time should protect from the wind and, therefore, promote the use of urban space (Johansson and Yahia, 2020). In warmer climates, effort must be made to reduce the heat-island effect, a result of denser urban populations, less vegetation and increased temperatures within urban areas (Asadi *et al*., 2020). The results of a study of Barcelona (Martin-Vide and Moreno-Garcia, 2020) revealed that the average intensity of the heat-island effect was approximately +2°C. Different studies have quantified the cultivation of green vegetation in urban spaces, both on facades and on roofs, and its impact on reducing the heat-island effect. Areas with trees can reduce

the temperature in outdoor areas by 2 to 4°C (Onishi *et al.*, 2010). Likewise, plant facades and roofs can reduce the temperature around buildings by 2 to 6°C (Perini *et al.*, 2011). Another measure is to increase the albedo of exterior building envelopes. For example, the average albedo of roofs will not usually exceed 0.30, but it can be increased to approximately 0.55 - 0.60 with reflective coatings (Bonafoni *et al.*, 2017). These measures also offer other environmental benefits such as improved air quality and energy savings (Perini *et al.*, 2011).

Acoustic comfort is a tolerable level of background noise that is not disturbing and causes no direct damage to health. The main sources of background noise within cities are traffic, industry and construction. A multidisciplinary approach to the so-called soundscape for managing noise environments involves not only physical measurements but also cooperation between the human and social sciences because perception of the environment varies between people (Levandoski *et al.*, 2020). In a study of the urban area of Quito, Ecuador, it was estimated that 25% of people are exposed to traffic noise levels above 65 dBA during the day, which are considered very high to undesirable levels. Noise mapping is fundamental to urban planning, mobility management, and policies to reduce noise pollution, especially in sensitive areas (Bravo-Moncayo *et al.*, 2019).

Light quality refers both to limiting light pollution at night and to regulating its minimum amount to provide adequate visibility for pedestrians, cyclists, and cars. Effective control must, on the one hand, be enforced to avoid over-lighting and glare, to regulate lighting according to use and to strongly limit the most polluting 'blue' shortwave light (Falchi *et al.*, 2011). On the other hand, besides minimum guaranteed visibility, appropriate lighting also increases safety and prevents crime. A study conducted in Texas (Suk and Walter, 2019) found that the highest levels of luminance corresponded to roads where no crime was committed. **Air quality** has a major impact on human health. As previously noted, recommended air-quality improvement measures include controlling vehicle and industrial emissions, as well as the use of green areas that reduce carbon dioxide levels (Zhang *et al.*, 2020).

In addition to visible and quantifiable aspects of place, urban residents develop a multidimensional relationship with the city in which they live, commonly known as **sense of place**. It refers to a human capability to arrange information from senses of sight, smell, touch, and hearing, as well as memory and imagination that relate to a particular place (Relph, 2020). The relationship between people and places takes into account perceptions of the different geographic features of a place (*e.g.*, pristine Alpine mountain landscape or Spanish cityscapes, traditional architecture in Tuscany, Italy), intangible culture (*e.g.*, traditional festivals or modern cultural events) and even economic activities (*e.g.*, cheese production in France or ski tourism in the Dolomites Region, Italy) (cf. Kianicka *et al.*, 2006). Sense of place is associated with feelings towards a place, place-related memories (*e.g.*, a neighbourhood inhabited as a child), experiences (*e.g.*, a place of study), social relationships with other people, and a sense of belonging and personal identification with a place, defined as place attachment. Nowadays, people have developed multiple place attachments (*e.g.*, to a place where parents raised their children, or to a second holiday home etc.) (cf. Claval, 1998). Sense of place changes with age; the geographical experience of children is mostly limited to the family home and immediate surroundings; place experience for adults is extensive, regional, and even global; while the sense of place for the elderly becomes increasingly constrained as mobility declines (Relph, 2020). Although visitors identify less with the places they visit, they can also develop a sense of place associated with their memories and feelings (*e.g.*, a place a parent or child might associate with holidays). Some places can evoke a stronger sense of place than others, which can be related to the identity of the place (cf. Paasi, 2011). Sense of place can also be negative, which is defined as place alienation. If a person cannot identify with a place or is dissatisfied with it, the feeling is associated either with a negative assessment (*e.g.*, neighbourhoods in a city with high crime rates and negative memories from a personal life) (Cross, 2001). Those places that lack place-based identification and emotional attachments are considered as placeless (Cross, 2001).

5 Nature

By Antonino Marvuglia, Javier Babí Almenar, Naomi Morishita-Steffen

> I am glad I shall never be young without wild country to be young in.
>
> Leopold 1949

The integration of nature in cities has a long history behind it, and yet on many occasions the potential of nature in cities have been disregarded in the environmentalist agenda (Grimm & Schindler, 2018). Over past decades, this trend has been reversed, and urban nature is more and more becoming part of urban strategies, plans, and policies (Cortinovis & Geneletti, 2018; Geneletti & Zardo, 2016; McPhearson, Hamstead & Kremer, 2014). Associated with this increasing interest, new ecological concepts emphasizing the value of nature have emerged and have quickly been transferred to urban studies over the past two decades. Green and blue infrastructure, ecosystem-based adaptation, ecosystem services, and lately, nature-based solutions (NBS), are part of this list of emerging concepts. In all cases, these concepts emphasize the value of nature for people in the form of benefits, and consequently, the enhancement or maintenance of their well-being (Nesshöver *et al.*, 2017).

In their literature review on the relationship between people's health and the built environment, Kent and Thompson (2014) proposed three domains where support for health and well-being can most effectively be focused on urban planning and:

1. The built environment and physical activity;
2. The built environment and connecting and strengthening communities;
3. The built environment and equitable access to healthy food.

NBS have the potential to contribute in all of the three areas by influencing citizen's behaviour towards a healthier lifestyle (increasing attractiveness of urban infrastructure that supports active transportation: walking paths, cycling lanes; supporting community interaction in safe and attractive public spaces) and by providing productive urban landscapes with sustainable food systems (urban agriculture and gardening), besides the other beneficial effects such pollution absorption, cooling effect of tree foliage and increased biodiversity.

Perhaps, from all the above concepts, NBS is the one that emphasizes the utilitarian aspect of nature to the largest extent. Current definitions of NBS describe it as cost-effective solutions, because it can concurrently provide environmental, social and economic benefits and address multiple societal challenges (Cohen-Shacham, *et al.* (Eds.), 2016; European Commission, 2015, 2016). The recent critical reviews carried out by Keeler *et al.* (2019) and Babí Almenar *et al.* (2021) identified recurrent benefits that different types of urban NBS can provide, as well as problems for which NBS could be suitable solutions. These reviews illustrate that urban NBS can mitigate urban heat-island effects and flooding risks and contribute to the enhancement of carbon sequestration, air and water quality, biodiversity, liveability of urban public spaces, and both the mental and the physical health of people. As a result of its multiple capacities, urban nature is clearly a relevant component to consider in the visioning of climate resilient, liveable and regenerative cities.

Regarding climate resilience, (Seddon *et al.* 2020) highlighted the prominence of NBS in the 168 Nationally Determined Contributions in support of the Paris Agreement that were submitted to the United Nations Framework Convention on Climate Change However, it is important to remark that with respect to other societal challenges, such as social cohesion and social equity, the co-involvement of citizens and the different groups of stakeholders are usually stressed as important factors to ensure the success of NBS interventions.

In terms of co-involvement of stakeholders, NBS communities should build a strong portfolio of evidence for the effectiveness and long-term positive outcomes of NBS, compared to other adaptation options (Kabisch *et al.*, 2016). Building this strong evidence, Kabisch *et al.* (2016) stressed the importance of developing locally relevant, context-specific indicators with which to measure progress towards meeting targets. These indicators and targets should be developed through a deep understanding of the effects of different nature-based interventions on social-ecological systems and their resilience under different climate change scenarios. Inevitably, to achieve this deep understanding, researchers, practitioners, and policy makers should be co-involved, thereby bringing together scientific, traditional and experiential knowledge. New NBS communities combining science, practice, and policy knowledge are in fact emerging, backed up by projects of international initiatives such as the H2020 of the European Commission. For example, the aim of the Horizon 2020 project Nature4Cities (www.nature4cities.eu) is to create a comprehensive reference platform for NBS, offering technical solutions, methods and tools to support urban planning decision-making. Platforms such as OPPLA (https://oppla.eu/nbs/case-studies) are also collecting successful examples of urban nature interventions, to serve as a guide for future projects.

A well-known example of an NBS community that implemented the first carbon neutral comunnity strategy to becoming the first carbon neutral community in North America is Eden Mills, Ontario, Canada. In 2007, community residents, determined not to wait for government or corporate action to address climate change, and launched a grassroots project, Eden Mills Going Carbon Neutral (Fig. 1.1.4).

Figure 1.1.4. *Township Mayor Chris White (far right) with his team installing the Eden Mills going Carbon Neutral sign. (Credit: Sword, 2010).*

The aim was to show that individuals and small groups of people of all ages could make a difference and inspire others to join their endeavors. These groups within the village decided to measure change by taking household surveys to determine baseline and changing carbon emissions. Among their projects, the community has implemented an ongoing community information campaign, village reforestation projects, a carbon-neutral renovation of the Heritage Community Hall (Fig. 1.1.5) with rigorous energy conservation strategies, a high-efficiency heating/cooling system and the installation of a photovoltaic roof array (Simon, 2015; Sword 2010). Individual inhabitants of Eden Millshave improved energy efficiency at home, have upgraded heating/cooling systems, built straw-bale homes, captured and reused local rainwater, and installed roof-mounted solar panels. Youth and children were involved at the launch of the Carbon Neutral Project, singing with the Carbon Neutral Youth Choir. The nearby University of Guelph has provided invaluable support. The project is dependent upon donations and has successfuly applied for government grants on occasions. This approach therefore informs and involves community members as stakeholders of the project.

Figure 1.1.5. *Eden Mills Heritage Hall after the deep thermal energy retrofit and photovoltaic installation. (Credit: Sword, 2010).*

Another village initiative undertaken by the Eden Mills Eramosa River Conservation Association was dedicated to re-naturalizing the river ways and estuaries within Eden Mills (Fig. 1.1.6), not only to benefit the local community, but also to help stabilize the overall hydrological cycle (Simon, 2020).

Figure 1.1.6. *Eramosa River east branch renaturalization project.* (Credit: Simon, 2019).

RESTORD 2030, (Brown 2020) as a small future city could learn from ongoing NBS community initiatives such as Eden Mills. It should also take advantage of the specific and multiple capacities of different NBS. As summarized in the mind map shown in Fig. 1.1.7, both aspects would help RESTORD 2030 to optimize the services that nature brings to the city.

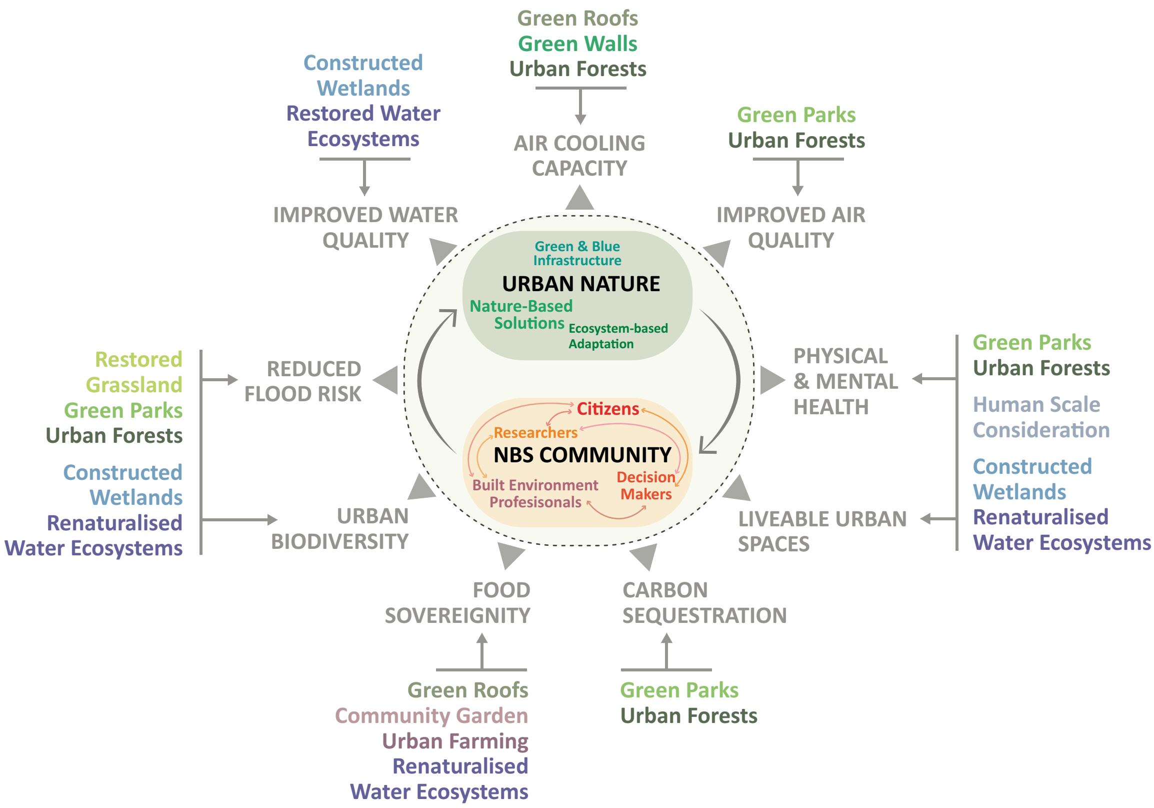


Figure 1.1.7. *Mind Map summarizing the benefits that a combination of urban nature and well-developed NBS communities could bring to existing and future cities.* (Source: Antonino Marvuglia).

The correct integration of **green roofs and green facades** in the buildings of RESTORD 2030 will keep indoor spaces colder and decrease the cooling load in summer, although green roofs and green facades in some climates can slightly increase the heating loads in winter. As a co-benefit, they could also become a source of food by following the example of Agripolis. Its inauguration, in Paris, of the largest green roof found in Europe that developed into a business profitable Edible Green Roof[1]. In fact, the use of edible green roofs, together with **community gardens** and other types of **urban farming** activities could help increase local food provision within RESTORD 2030. These activities would contribute to the food independency or food sovereignty of the city, and more importantly to ensuring a resilient and sustainable city.

A well-distributed network of **green parks and community gardens** in RESTORD 2030 could positively refesh the mental health of its citizens and provide places for physical exercise and reconnection with nature as well as with community building. For example, the Magneten Sensory Garden (Denmark), developed by MASU Planning, is an aromatic garden with a focus on special needs visitors, helping to alleviate mental health issues. Green open spaces that are well distributed in terms of social interaction, with principles of green justice guiding implementation and working conditions leaves little room for green gentrification issues and creates a more equitable network of open spaces. In the same sense, well distributed green open spaces can from a physical point of view serve to assist with flood control, water flow regulation and as biodiversity stepping-stones.

In RESTORD 2030, **urban forests** can also contribute to enhance biodiversity and water flow regulation, while positive climatic effects are attributed to CO2 reduction, urban heat-island mitigation, and better air quality. For example, a metropolitan network of urban forests within Madrid, the capital city of Spain, addresses air pollution issues, and as a co-benefit improves its biodiversity connectivity and nature-based recreation. Another similar project, the Metro Forest Project (LAB - Landscape Architects of Bangkok), has targeted the restoration of forest for biodiversity, offering an educative connection with nature.

The nature-based urban strategy of RESTORD 2030 should also consider how urban water use can complement and replenish the hydrological cycle. **Grassland restoration** and **natural sequence farming** in the surrounding areas of the city are two ways to reverse the effects of desertification (Von Weizsäcker & Wijkman, 2018), mitigating extreme runoff and flash floods. **Urban wetlands**, and even constructed wetlands, can be used for wastewater treatment by reducing energetic resources used for wastewater treatment, while increasing the amount of urban vegetation and promoting biodiversity through the flora and fauna of a wetland habitat (Stefanikis, 2015). For example, Qunli National Urban Wetland (China), designed by Turenscape (Fig. 1.1.8), is positive for urban biodiversity, nature-based recreation and water depuration. In a similar sense, a **re-naturalisation of bays and estuaries** could mitigate extreme flooding and precipitation, improve water cleansing, nature-based recreation, aquatic biodiversity, and examples of food supply capacity. One example is the Oyster[2] texture project in New York, which targets the re-naturalisation of estuaries and bays using oysters for water depuration, their regenerated habitats serving as a barrier to mitigate sea waves. It is expected that their condition of keystone species and food sources will contribute to biodiversity enhancement and food supply in the long-term.

Finally, besides urban nature, RESTORD 2030 plans to rely on an efficient **network of public transport infrastructure**, promoting public transport use and bike lanes, rather than cars. A people-centered size and form of the transport network space must be considered, the way they interact and build spontaneous social relations (the "human scale" concept developed by J. Gehl). The network should also be interconnected, in so far as possible, with the network of green open spaces. As a result, people will feel that the city was built to be lived within and enjoyed, creating liveable open spaces, and rather than imposing barriers, transport infrastructure will become biodiversity corridors of ecological connectivity.

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1 http://agripolis.eu/project/la-plus-grande-ferme-urbaine-en-toiture-au-monde/

2 https://www.scapestudio.com/projects/oyster-tecture/

Figure 1.1.8. *Aerial view of the Qunli National Urban Wetland (China) Picture Sara Daneshmand used with permission.*

Acknowledgements

Javier Babí Almenar would like to acknowledge funding from the European Union's Horizon 2020 research and innovation programme under Grant 494 No: 730468 (www.nature4cities.eu).

6 Energy

By Rosa Romano, Emanuela Giancola, Elisabetta Palumbo, Antonino Marvuglia

From Nearly Zero Energy Buildings (NZEB) to Positive Energy Buildings (PEBs) and Positive Energy Districts (PEDs)

In many industrial and highly populated countries, research into high energetic consumption within most cities, is promoting the concept of "Low Carbon Cities". Its primary concept has to date been on ways to reduce the impacts of current energy consumption in transportation and buildings. Energy is the lifeblood of economic development and modern society. In contemporary economic developments, energy tends to become a significant political, social, and economic objective (Popescu *et al.*, 2019). According to The World Energy Outlook 2018 (IEA, 2018), based on current and scheduled policies, projected energy demand in 2040 will have grown by more than 25%.

The "low carbon city" concept is complemented within the broader notion of regenerative city. Through the potential of recent scientific-technological advances and 'smart' innovation, a regenerative city not only preserves environmental stocks, but moreover restores and regenerates these from previous losses (Axinte *et al.*, 2019).

In so far as it may, a regenerative city needs to make careful use of energy and harness renewable energies to power buildings and activities.

Promoting restorative actions for urban regeneration necessarily requires some reflection on productive renewable energy technologies (PV, solar thermal panels, geothermal, biomass, etc.) that can be integrated into the building envelope and/or urban districts to reduce human environmental impact.

Renewable energies not only help to decrease the building energy consumption to zero, but also the emissions of CO_2 and other climate-altering substances, throughout the life cycle of the building, with a view to continuously protecting the environment and its resources.

Over recent years, many European Community programmes have funded (micro to macro scale) renewable energies within the building sector, to overcome the **nearly Zero Energy Building (nZEB)** target, introducing the new concepts of **Plus Energy Buildings (PEBs)**. Especially the "Buildings design for new highly energy performing buildings"[1] call, focused on development and demonstration of applied solutions, which significantly reduce the cost of new buildings with at least 'nearly zero-energy' performance levels, whilst significantly accelerating the speed with which these buildings and their systems find a way into the mainstream market. The innovative solutions should address the challenge to move towards a 'Positive Energy Building" (PEB) standard on a large scale with demonstration projects that go beyond the "traditional" 'nearly-zero energy' buildings" levels, to the point where buildings are active contributors to energy production and environmental quality in particular when new neighbours are planned (*e.g.*, Positive Energy Districts).

PEBs can, in fact, produce more energy than they consume and supply energy to other nearby buildings, creating a system of inter-connected units at neighbourhood level, aiming at least to achieve energetic neutrality or, in extreme cases, energy positivity (Magrini *et al.*, 2020).

Moreover, a PEB not only aims to harness renewable energy (*e.g.*, electricity, mainly from photovoltaic systems, rather than from wind turbines or other sources), but it must also pay attention to the purpose and distribution of excess resources upstream (Cole and Fedoruk, 2015).

Rather than an individual and isolated PEB, it is interesting to scale jump to the concept of a **Positive Energy District (PEDs)**, composed of several interconnected buildings at neighbourhood level, contributing

to the energy supply through a “smart” distribution of energy networks. The spread of these types of buildings would have positive implications for the three spheres of sustainability:
- Environment, reduction of CO^2 emissions thanks to the use of clean energy from Renewable Energy Sources (Directive 2009/28/EU);- Society, forming a solidarity-based community, working towards the common purpose of energy support;
- Economy, compared to the initial investment in smart grids and integration of RES in buildings, users can count on economic savings in energy costs.
In 2017, the EU launched the “Positive Energy Districts and Neighbourhoods for Sustainable Urban Development” programme, in order to achieve its ambitious energy objectives. The programme forms part of the SET Plan Action 3.2 “Smart Cities and Communities”, which aims to support the planning, deployment and replication of 100 PEDs by 2025 with the support of 20 Member States.
In line with the SET Plan Action 3.2, specific recent initiatives on the study of PEDs may be mentioned, which were recently launched, such as the Cost Action CA19126 - Positive Energy Districts European Network (Cost Action CA19126) and the International Energy Agency (IEA), EBC Program - Annex 83 - Positive Energy Districts.

Embodied energy versus Operational Energy

However, is it enough to focus on current energy consumption alone? Analysing the current energy consumption of a city alone can lead to the conclusion that urban areas, in particular densely populated ones, are relatively efficient, largely because per-capita current energy consumption is lower than in dispersed urban or suburban arrangements. However, what is not measured as part of the energy impact of urban areas is the built space itself — the streets, pavement, buildings, utilities, tunnels, etc. — that are required to maintain such a dense arrangement of humans. In addition, the energy used to manufacture the array of consumer goods and services that urban residents purchase and their onward transportation for sale is not taken into account either.
Embodied Energy (EE) is the sum of all the (direct and indirect) energy required to produce goods and services, whether environmental or economic in nature. It is different from the direct energy measurement of energy consumption. EE refers to the energy consumed by all other products and services used to process and to manufacture the product, as well as to maintain it. For example, in the literature on building and construction engineering, EE refers to the energy embedded in all products and services used by a building from its design, construction, useful life (maintenance and replacement) up to final demolition (recycling and reuse), in other words the EE consumed throughout the whole life-cycle of the building (Dixit, Culp & Fernández-Solís, 2013; Dixit, 2019). It differs from energy consumption throughout both the useful life (operational energy) and the construction phases of the building, concepts that only reflect the direct energy that is consumed.
Scientific literature has shown the need for appropriate analysis metrics and weighting systems to properly characterize nZEB and the importance of the EE an indicator in a building energy analysis. Giordano *et al.* (2017) assessed whether EE is a valuable indicator that should be included in building energy analysis along with Operational Energy (OE) and if they can both be taken into account at an early design stage. The EE and OE assessment presented in this scientific work was carried out considering the International Energy Agency (IEA), Solar Heating & Cooling Program, Task 40, Annex 52, and the IEA, Evaluation of Embodied Energy and CO_{2eq} for Building Constructions, Annex 57.

Furthermore, the paper shows that EE increases, because of the use of energy-intensive materials, while the OE calculation is influenced by the solar gain, the shadowing factor and the heat transfer factor.
Current legislation within European Countries aims at Zero Emission Buildings, mainly through OE minimization (Tingley & Davison, 2011). However, an nZEB building can not always be defined as a Zero Carbon Building (ZCB), even if it is true that optimization of the useful life phase can lower CO_2 emissions, because it cannot be guaranteed that the materials and components chosen during the construction phase have as low an impact from the environmental point of view.
Accordingly, future NZEB implementations must address proper balance metrics and a weighting system. So far, only very few countries have introduced requirements pertaining to EE, mainly due to the lack of national and agreed EE databases for building materials. Furthermore, a weighing scale among energy analysis factors requires investigation.
Finally, the discussions on EE and OE should be extended to Embodied Carbon (equivalent carbon dioxide emissions).

LCA VS eMERGY

The crucial issue that needs to be addressed is the identification of a balance between the different energy consumption sources and their related environmental impacts, considering a life cycle perspective.
A recognized, suitable and standardized (ISO 14040:2006 and ISO 14044:2018) method for measuring environmental sustainability over the whole life cycle is **Life Cycle Assessment (LCA)**. Although still difficult to apply at district level, the use of LCA for environmental impact assessments of construction products and buildings in the last 25 years has been increasing.
Therefore, it is evident that the design and operation of both buildings and urban districts should be inspired by LCA principles and possibly, for a fuller connection with nature, the assessments obtained with the principles of LCA are complemented by those made using **Emergy** (spelled with an "m") analysis (EMA).
The concept of Emergy, initially developed by American ecologist H.T. Odum in the 1980s, is defined as the total available energy (exergy) of one kind that was required (used up) both directly and indirectly in either making a product or offering a service.
Emergy is based on a donor-side (*i.e.*, nature-oriented) perspective, as opposed to the traditionally human-oriented perspective on which LCA-based assessments are founded. Known as a **paradigm shift**, emergy implies that EMA estimates of resource value should not only be based on resource scarcity and the consequent extraction costs for humans (as with LCA), but also on the global effort by nature (called also geo-biosphere work) that make those resources available. EMA could even be imagined as an alternative way to define circularity indicators.
While LCA are traditionally used to assess the sustainability of products and policies, Emergy is more suitable for assessments of a region or an ecosystem, where there is a clear interface between the antropho-sphere and the natural systems and the study of human activities is well embedded within the contextual contribution of natural capital. Emergy aggregates energy and matter flows of a different nature into a common numeraire, which express the amount of **equivalent solar energy** invested by nature in the production of a unit quantity of a delivered resource.
The appealing features of EMA are: its internally consistent "donor-side" theory of value; the common numeraire for all inputs and processes (both natural and human-dominated). Its negative characteristics are: it is harder to explain the rationale for the inclusion of resource formation processes, and the complex language needed for its communication is never easy.

In some areas, the application of EMA will be sub-optimal, when:

1. Assessing the “eMERGY cost” or “sustainability” of individual products and systems taken in isolation from the larger system in which they are embedded (e.g., a single car, one computer, etc.);
2. Replacing monetary costs on the scale of the (local) economy;
3. Assessing individual technosphere systems in general whose temporal and spatial scales are much smaller than those of resource (re)generation.

The approaches based on LCA and EMA are therefore, to some extent, complementary and can sometimes be integrated.
The critical concepts set out in the present text - “Energy Positive District”, “eMergy”, “low carbon and resilient city”, “life cycle vision”- are interconnected with the wider research topic “Restore Energy Pattern” through complementary relationships that are neither linear nor hierarchical (Fig. 1.1.9).

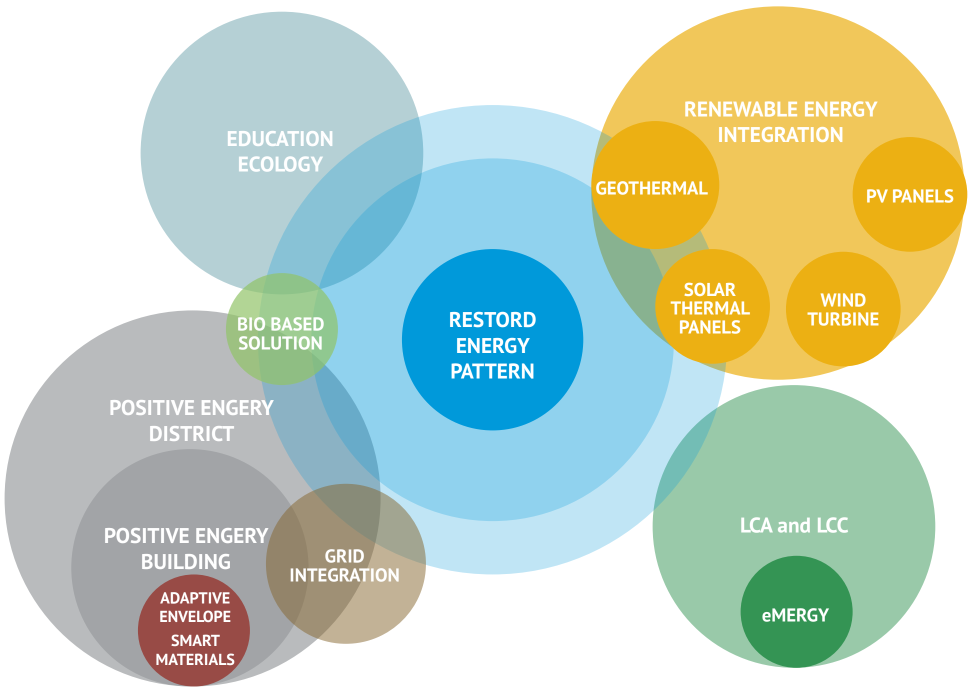

Figure 1.1.9. *Conceptual diagram of Restore energy pattern. (Source: Antonino Marvuglia).*

7 Materials

By Emanuela Giancola, Jelena Brajković Martin Brown, Naomi Morishita-Steffen

Scale Jumping to Regenerative Material

> In the current pursuit of low carbon buildings … can all roads lead to timber?
>
> (Brown 2020)

All roads may appear to lead to timber as the solution in the current carbon/climate agenda, it is not however a silver bullet.

- timber has to be from a sustainable source, ideally local;
- there needs to be a sound sustainable forestry supply chain with capacity and capability;
- landfilling timber at end of life may have a greater impact than using other higher embodied carbon materials;
- the above requires carbon design for deconstruction and a circular economy;
- core materials (steel concrete) will still have a place and will therefore need their own decarbonization agendas and transformations.

Past Damage to Scotland's Flow Country

Flow Country in northern Scotland is the largest European expanse of blanket bog, covering 4,000 km². It was severely damaged between 1979 and 1987 through misguided planting of non-native conifer forests (cash crops) for construction and other industries, and in the process thousands of miles of newly dug ditches damaged natural drainage patterns. The trees dried out the peat, changing the habitat and destroying its value for birds and other wildlife. Only now, some 40 years later, is a multi-million pound 'back to nature' project working to remove the conifer trees and to restore the biodiversity of the natural peatlands that are also efficient carbon sinks.

Conifer cash cropping in all probability continues worldwide, illustrating the need for a responsible approach to construction materials. Up to 40% of all carbon from wood used in building construction has come through irresponsible timber practices, such as those described in the Flow Country, removing an important natural CO2 balancing mechanism from the ecosystem.

Socially Just Materials

Health and its social impact on humans have emerged as vital criteria for materials used within the built environment alongside environmental and planetary health. It includes health and planetary impact and social justice considerations, in relation to material extraction, manufacture, storage and transportation, and construction, whether in use, adapted for reuse, or undergoing final demolition and disposal. Transparency and verification is offered through such platforms as Declare/Living Building Challenge. However, although expanding, these considerations occupy only a small niche area of sustainable buildings. It is therefore important to expand and to scale jump the use of red list and precautionary principles from within regenerative standards (LBC, Well), applying them to all projects irrespective of standards. Some examples are the Material Schedule approaches from developers British Land and contractors Baxall (UK).

Carbon

If we are to achieve carbon targets (net zero) in line with Paris and other IPCC reports, we have to rapidly remove embodied carbon from both new built environments and from the refurbishment of the existing building stock. This can only be achieved through using bio-based materials, in particular organic materials that have sequestered carbon during their growth.
The Cuerden Valley Park Visitor Centre, Lancashire, (Fig.1.1.10), the first building designed and constructed in the UK in accordance with the Living Building Challenge, demonstrates that it is possible to construct without the use of cement or concrete products. Application of bio-based materials in compliance with the Living Building Challenge Red List (ILFI), depicted in the Circular Economy butterfly diagram, mean that all materials used on the project have a future life through the natural (composting) or technical (reusing, repurposing) waste streams.

Figure 1.1.10. *Cuerden Valley Park Visitor Center (Credit: M. Brown).*

In 2013, Chris Magwood referred to embodied carbon as the carbon elephant in the room (Magwood): "hardly anybody was accounting for this significant amount of emissions. Instead, all the focus was on making buildings more energy efficient. While efficiency is important, reductions in material emissions are immediate and therefore more impactful in reducing atmospheric carbon concentration now, rather than in the future"

Upfront carbon

Whilst we continue to use the language of embodied carbon, it maintains a level of mystery and misunderstanding, along with a 'this-is-too-difficult' attitude, a mask behind which we hide our inactivity.
Milne, G. (2013) commented that EE is the energy consumed by all of the processes associated with the production of a building, from the mining and processing of natural resources to manufacturing, transport and delivery of the finished product. Embodied energy does not include the operation and disposal of the building material, which would be considered in a life cycle approach. Embodied energy is the 'upstream' or 'front-end' component of the life-cycle impact of a home.

Considering the Blue Economy in New Material Production

The blue economy is an economic model responding to the basic needs of everyone and everything with nature-inspired innovations with multiple benefits. Created by Gunter Pauli, in 2004, the model places nature at the centre of the economy. Jobs and social capital are provided while producing more with less resources. Physics and biology drive solutions, and only necessary needs are met with no excess production and no waste: encouraging biodiversity and diversity and discouraging industrial standardization. Companies are also diverse with no monopolies. Gravity is the main energy source, and solar is the second renewable energy. Water is the main solvent with simple chemical compounds and non-toxic catalysts (Pauli, 2004).
The model and vision are based on the premise of natural resilience. Nature has overcome and will continue to overcome disasters with beautiful and unexpected solutions (Weizsäcker and Wijkman, 2018). Innovation is the norm, because nature is constantly changing. The economic model is turned on its head starting from sufficiency and growing to abundance. Economies of scope include natural innovations that have several benefits for the common good. Nature is the starting point. All components are biodegradable over time.
The 21 Principles of the Blue Economy consider nature, society, physics, biology, and joy and happiness (Weizsäcker and Wijkman, 2018), among others. Only local materials are used in blue economy products. Sustainable business evolves with local resources, culture and tradition bringing resilience in challenging times, identity, and joy in periods of abundance. Natural systems are non-linear, connected and evolving towards symbiosis. Natural elements of clean water, clean air and fertile soil are abundant and free. Risks are motivators for innovations and when risks are shared by everyone, problems turn into opportunities (Pauli, 2004; Weizsäcker and Wijkman, 2018).
Self-healing concrete is a restorative material. Payne *et al.* developed a biomimetic self-healing concrete as part of the Resilient Materials for Life Program (RM4L). The concrete mixture contains bacteria spores in isolated microencapsulations throughout the concrete. The bacteria react with the calcium carbonate growth medium that precipitates CACO3 in a chemically expansive reaction, filling the crack (Payne *et al.*, 2019).

Scale jumping in this sense is utilizing the natural chemical reactions between bacteria and calcium carbonate in concrete at a microbiotic and microscopic scale applied to a mesoscale item such as a concrete building, or bridge structure or the like. The philosophy and integration of elements working simultaneously throughout each scale is discussed in great detail in (Bejtullahu and Morishita-Steffen, 2020).

8 Education

By Giulia Sonetti, Antje Disterheft, Martin Brown

Education for Regenerative Sustainability: some reflections on scale-jumping in times of a pandemic

> I used to think the top environmental problems were biodiversity loss, ecosystem collapse and climate change. I thought with 30 years of good science we could address those problems. But I was wrong. The top environmental problems are selfishness, greed and apathy… And to deal with these we need a spiritual and cultural transformation - and we scientists don't know how to do that.
>
> James Gustave Speth, American environmental lawyer and advocate, Former administrator of the United Nations Development Programme.

How is education adapting to the planetary disruption and upheaval of COVID-19? And is there space for a sustainability-centered redesign of the entire educational system throughout continuous localized lockdowns? We believe so and we sincerely hope so.

In this short essay, we offer reflections on Education for regenerative sustainability in the midst of a pandemic and what the opportunity of scale-jumping could mean within an educational context. We start by clarifying some of the terminology used and we then provide some reflections on scale-jumping in sustainability-related education, aiming to outline what a responsible scale-jump might mean, in the context of recent global events.

Regenerative

The term "regenerative" has entered many sustainability discourses in the past years, with an emphasis on the built environment and design (Hes and Du Plessis, 2014; Mang and Reed, 2012; Robinson *et al.*, 2014), and may eventually even be considered the "new regenerative sustainability" (Gibbons, 2020). Scholars have emphasized that regenerative sustainability, in contrast to conventional and contemporary sustainability, is likely to follow a holistic worldview, promote co-creation, focus on deep leverage points and thriving living systems, and therefore be more inspirational and motivational than seeking system maintenance as in conventional sustainability (Gibbons, 2020; Wahl, 2016). Interestingly, in the literature around

education for sustainable development (ESD)/education for sustainability (EfS) we can find many overlaps with this understanding of "regenerative": such scholars as David Orr, Arjen Wals, Stephen Sterling, just to name a few, have contributed substantially to a holistic approach in education for sustainability, challenging established educational practices and pedagogies (Orr, 2006, 2002; Sterling, 2017; Sterling *et al.*, 2018; Wals, 2007; Wals and Peters, 2017). They and many other scholars and practitioners have inspired and influenced a host of educators and policymakers regarding the need to rethink education, calling for social, transformative and transgressive learning (Lotz-Sisitka *et al.*, 2015), more collaborative and participatory teaching approaches. They call for an alignment with the understanding of regenerative sustainability. This perspective is, however, not necessarily shared by the more mainstream visions of ESD.
The term regenerative illustrated through the built environment perspective from the International Living Future Institute (ILFI), a non-profit group working towards an ecologically-minded, restorative world for all people, is not limited to a 'better' environmental sustainability that brings additional benefits, and has a far wider systemic and holistic scope. This approach can be seen as a regenerative update to the triple bottom line (environment, social and business - John Elkington (2001) and the Patrick Geddes triptych of Work-Place-Folk (Clark, 1997).

It can be argued then that regenerative sustainability students, or the elements of regenerative sustainability embedded in the education of all built-environment artesanal, technical and management students needs to be neo-generalistic, with a deep awareness of the human, nature and built-environment nexus

Education for Sustainable Development (ESD)

As defined by UNESCO (UNESCO, 2019a), ESD seeks to "empower people to change the way they think and work towards a sustainable future, (...) including sustainable development issues, such as climate change and biodiversity into teaching and learning. Individuals are encouraged to be responsible actors who resolve challenges, respect cultural diversity and contribute to creating a more sustainable world". Even though ESD calls for transformative learning (United Nations Educational, 2014), and strives for societal transformation, in particular in support of achieving the Sustainable Development Goals (SDGs), it might rather reflect a contemporary understanding of sustainability: aspects of co-creation and thriving living systems are not (yet?) the focus; the concept of continuous economic growth is not contested (SDG 8), it is rather seen as a means to achieve quality education for all (SDG4). Also aspects of our inner worlds - emotions, awareness, consciousness, values - are not yet fully considered in our educational approaches for sustainability (Christine, 2020; Ives *et al.*, 2020). Drawing attention to inequalities in access to education and the "globalization of indifference", Pope Francis stated that the "educational compact is in a state of breakdown and can only be fixed through a renewed universal effort of generosity and cooperation involving families, schools and social, cultural, religious institutions.", and "education alone cannot solve all development challenges, but a humanistic and holistic approach should contribute to achieving a new model, guided by environmental stewardship, a concern for peace, inclusion and social justice." (UNESCO, 2019b).

The Pope's vision likewise resonated with UNESCO's humanistic message at the basis of the "Futures of Education" project and UNESCO's work to integrate global citizenship and sustainable development into learning contents (Albareda-Tiana *et al.*, 2020; Sonetti *et al.*, 2019).

Scaling and scale-jump

Scaling can be looked at from different perspectives. Often, scaling up is first understood as becoming larger, but Uvin (Uvin *et al.*, 2000) suggested that scaling up should refer to expanding the *positive*, (authors' italics) impact, and can be divided into *quantitative, functional*, *political* and *organisational scaling up* (*ibid*.) Similar concepts to 'scaling up' are 'replication', 'expanding', 'going to scale', 'mainstreaming', 'rolling out', 'growing', 'scaling out', 'developing' (Mickelsson *et al.*, 2019). In EfS, scholars call for non-linear scaling and the use of a multidimensional approach (Duggan *et al.*, 2013): this includes three layers: *horizontal scaling*, *vertical scaling*, as well as *scaling in* (*ibid*.). Horizontal scaling tackles the geographical spread, while vertical scaling addresses the institutional dimension of expanding the diversity of stakeholder groups and actors in the process, and scaling brings with it value systems and cultural considerations (*ibid*.). Such a multidimensional approach appears very important to us, as the scaling of educational activities can also have downside effects, such as cultural colonization (Dei, 2009; Hartmann, 2019). Mickelsson *et al.* (2019) offered an inspiring perspective to see scaling ESD as a matter of learning. In their participatory research project *re-solve*, they developed the re-solve tool that is based on John Dewey's learning theory (Dewey, 1958) and emphasizes transactional and transformative learning. Scaling is seen as an emerging learning process. This process, multidimensional in nature according to the other above-mentioned scholars, also includes scaling as business unususal (as opposed to business as usual). Such a perspective would fit the understanding of regenerative sustainability and transgressive learning, as scaling sustainability education activities will imply the decolonization of thought processes and might challenge conventional views on sustainability. Regenerative thinking is focused on developing capacity and capability for systems evolution (Mang and Reed, 2012): the need of a mindset scale jump, where nature is seen as a measure and mentor, should pervade all levels of education, and all disciplines (Balsiger *et al.*, 2017; O'Riordan *et al.*, 2020). A scale jump in education should be about creating systemic awareness (places, buildings, communities, organisations), so that the single elements may increase their capacity to evolve toward increasing states of health and to thrive over time (Bina *et al.*, 2017; Ferreira *et al.*, 2019).

So what? Reflections on scaling education for regenerative sustainability

George Monbiot observed that our consumerist society prioritizes and awards cultural literacy over environmental literacy, making a case for the fundamental value of ecological education, that we should be "placing ecology and earth systems at the heart of learning, just as they are at the heart of life"(George Monbiot, "Coronavirus shows us it's time to rethink everything. Let's start with education," The Guardian (May 12, 2020))

Regenerative sustainability ....

Deschooling (Illich, 1971; Scharmer, 2018) our educational places may be the first brave new step we need to take to exploit the full potential of already-existing hubs, shaped and sometimes reinforced during the pandemic, for catalysing sustainability transitions beyond conventional and contemporary sustainability. Talking about Higher Education Institutions, John Scott (Scott, 2006) recalled the much-needed postmodernist shift of each university's mission "from teaching to research as a tool for public service, embedded within a framework of globalization, to engage with real societal demands and link the university with its socioeconomic context" (Chelleri and Sonetti, 2017). However, this third mission still focuses primarily

on economic development and technology transfer, while scholars call for going beyond the third mission towards universities that co-create for sustainability (Trencher *et al.*, 2014).
Claims in a recent article (Eirdosh and Hanisch, 2020) that if sustainability education aims at purely practical learning opportunities for solving urgent real-world problems, this problem-centred approach may then also obscure the broader potential of the landscape.
On the contrary, we argue that sustainability education is not only and just pragmatism. Today's world calls for community education to face the wicked and complex challenges before it,. Complex because they involve the perspectives of many people: those directly affected by the problem, those with the scientific tools for their analysis, decision-makers empowered to implement a solution (Pohl and Hadorn, 2008). It seems that these challenges are on the rise, and a scale-jump in sustainability education should not only foster problem and project-based approaches, but broader transformative and transdisciplinary approaches, bringing together all actors (Pohl and Hadorn, 2007). This shift of focus towards the education of agents for immediate change, involving every profession (architects, engineers, urban planners, but also health-care professionals, entrepreneurs, artists, educators on all levels, to name very few), because it is an urgent task for all to foster this regenerative shift that we seek.
Engaging with experiential education for sustainability is just one of the methods that may have a grip for critical thinking and behavioural/mindset change, that is the ultimate focus of education for sustainability. "Even when problems may be solvable through engineering and technological innovations, they still require a citizenry capable of supporting the scientific and democratic institutions to develop and deploy such innovation. More so, a vast majority of problems are deeply rooted in the cultural institutions, norms, biases, and individual level dispositions that variously enable and constrain our collective potential to achieve progress on the grand challenges of our times." (Eirdosh and Hanisch, 2020).
That is why scale-jumping in the current educational approach should bring a transdisciplinary literacy at the base of any taught discipline, assembling scientists, decision-makers, and affected people (stakeholders) to cooperate as they analyse the problems, develop what they foresee as desirable futures, and work on strategies and actions supporting the necessary changes. Even the Pope, with the Encyclical Laudato Si' (Francis, 2015), dared to call for "an ecological conversion through education, recognizing the need for lifestyle, production and consumption changes. Education systems must embrace the spiritual dimensions of every person, the notion of common good and the need to take local actions for the global good" (Sciences, 2017). This shift overcomes disciplinary barriers and calls for a network analysis of our immersion in a knowledge system, as Bruno Latour (Latour, 2017) argued, to illustrate the more-than-human assembly of knowledge performers within current education and transit to a less rational and more relational educational system (Fenwick and Edwards, 2014).
Since "there is no transition without transformation" (Bina and Pereira, 2020), scaling education for regenerative sustainability will require a transformative learning approach, that is "to teaching based on promoting change, where educators challenge learners to critically question and assess the integrity of their deeply held assumptions about how they relate to the world around them," (Mezirow and Taylor, 2009, p.xi). Rather than understanding education as a linear process towards predefined goals, the one for regenerative sustainability requires both educators and students to embrace such values as "uncertainty", "relationality", and "community", what De Sousa (de Sousa Santos, 2015) characterized as ecologies of knowledge. However "inherent to such ecologies of knowledge is the need for epistemological justice, whereby a strong characteristic of transgressive learning is the role of dissonance to disrupt and question fixed values and beliefs." (Macintyre *et al.*, 2020, p.15).
Fixed values and beliefs, and above all the current cultural and economic model, and on the top of that, the current pandemic, may seem insurmountable and unmovable mountains, especially when aware that the pandemic has increased inequality, in particular for low-income countries: 90% of students around the world were unable to go to schools, reversing years of progress on education (Guterres, 2020).

However, COVID-19 might also be giving us enormous opportunities to scale up learning for sustainability:

> To rethink our societal learning infrastructures, from an individual, teacher-centric learning by listening towards learning by doing and by co-creating with all actors of the team, to perceive that we are all part of a living ecosystem.
> To rethink (and scale-up) our competences as educators that can help facilitate the type of learning approaches we have been describing here as a particular individual alignment with regenerative sustainability.
> To pause and to reflect. International voices, such as UN General Secretary António Guterres, who sees the pandemic as a wake-up call by Mother Earth (UN news, 2020), also Indian author Arundhati Roy, who calls for the pandemic to become a portal for transformation (Arundhati, 2020), and citizen groups around the globe calling for not going back to normal, as normal was the problem (Collectif, 2020).

As this book focuses on the intersection between human, nature and the built environment, we propose specific aspects of the built environment for education.
Regenerative sustainability literacy in mainstream built-environment education is woefully lacking, throughout education for trades and manual crafts and the management, design and services education. We need to ask ourselves whether students are properly prepared to address climate and ecological emergencies, in particular, regenerative, nature-based solutions that will increasingly be in demand by clients within the next decade, as they seek regenerative facilities and work towards regenerative building standards. Commencing built-environment education at the earliest stages with an understanding of ecology, the bio-ecology of plants and trees and how that is applied to building nature-based solutions is essential. The UK based Architects Climate Action Network (ACAN 2020) has called for a deeper understanding of climate science and strategies for an adaptive and resilient built environment, curricular themes hardly found in schools. However, the solution to fix is not just within schools of architecture or construction trades, it is up to clients, institutions and sustainability organizations, to voice concerns over curricular educational.
Eventually, we wish to call for responsible scaling of sustainability-related learning activities: education for regenerative sustainability lays stress on the importance of local knowledge, empowerment, co-creation and capacity building, while at the same time enhancing structural conditions that create positive learning environments, enable deep communion with nature, the integrative attitude of honouring indigenous philosophies and promoting a holistic worldview, to foster interconnectedness and interbeing-ness (Disterheft *et al.*, 2016; Macy and Brown, 2014; Thich Nhat and Tworkov, 2020). As pointed out by Otto Scharmer in his Theory-U for organizational change (Eisler *et al.*, 2016; Scharmer, 2018), it is a question of broadening and deepening the learning cycle towards setting the basis for our institutions in the praxis of transforming society and self. Indeed, there is no transition without transformation (Bina and Pereira, 2020), and societal and personal transformation is originally not separate — they are two different aspects of the same deeper evolutionary process.
We have a generational opportunity to reimagine education: supporting this process in ways that are more intentional, systemic, personal, and practical may well be the biggest single leverage point for scale jumping in the current educational system for regenerative futures.

9 Equity

By Naomi Morishita-Steffen, Martin Brown, Doriana Matraku Dervishi

The definition of equity has evolved from the first definition of equity in the Shorter Oxford English Dictionary that began with fairness and justice (Oxford University Press, 1997), yet in 2020, the first equity definition in the Oxford Learner's Dictionaries is "[uncountable] (*finance*) the value of a company's shares; the value of a property after all charges and debts have been paid." (Oxford University Press, 2020).

Governments are now waiving public privacy rights to track the movement of people infected with the Covid-19 virus using location data from their own electronic devices. Digital technologies are changing the workforce, jobs are replaced by technology and new poor quality and poorly paid jobs proliferate. A handful of technology companies are amassing wealth and power, yet they are not taking responsibility for the lost jobs or negative impacts of their decisions.

There are several advantages for those who can afford digital technologies. Those who cannot afford digital technologies are at higher risk of infection because they must accept lower-paid jobs with higher health risks. They are also being left behind due to a lack of digital access and a lack of investment needed to use digital technologies within education. Privacy rights need to be protected, personal data must not be shared, especially without consent, or sold electronically, to the benefit of private corporations and government bodies.

Businesses benefitting from the pandemic are grocery stores, food producers, virtual desktops for remote work from home, enterprise video communications, disinfection products, video streaming services, and pharmaceutical corporations (Barro, 2020). Naomi Klein states that the large American corporations are lobbying to sacrifice personal privacy and quality to maintain a competitive edge over Chinese high-tech companies, their direct competitors. The American high-tech multinationals are asking the American government for permanent lax safety and privacy laws, in the name of competition, even after the pandemic passes (Klein, 2020).

"Essential workers" in health care, grocery stores, food and meat packaging, factories for pharmaceutical companies, restaurants, public transport, and delivery services, have poorly paid jobs but are essential to infrastructure in daily use and its maintenance. They sustain economic activity without the option to isolate, risking exposure to the virus, because they cannot afford not to work (OECD, 2020; The Lancet, 2020). Often, essential workers are not eligible for furloughed benefits, as they are part-time workers, migrants, seasonal workers, or illegally employed in the underground economy (The Lancet, 2020).

Every nation of the United Nations (UN) that committed to UN Transforming our World, the 2030 Agenda for Sustainable Development, committed its peoples to improving the lives of the global population by 2030. Yet inequality in income and the economy is also reflected by the division of wealth. The impact of Covid-19 has exaggerated the already existing trend amassing wealth in the hands of a few. Poverty is increasing; wealth, power, and privilege are exclusive to the wealthy, complicating any progress towards SDGA 2030 in the current situation (International Labour Organization, 2020; OECD, 2020). A specifically vulnerable group, indigenous women, are 20% more likely to be working in the informal economy than to have found employment in a full-time job with social and health benefits (International Labour Organization, 2020).

A regenerative economy is very important to accommodate social justice for all within the purely natural context. It is time to adapt economic models that reflect a democracy and that benefit the common good of the entire population, instead of benefitting a select privileged few. The Covid-19 pandemic is showing that economic health is strongly correlated with the health of the planet. By replacing labour with

AI-driven learning machines, the concentration of wealth can be accelerated even faster, leaving even larger numbers of the inhabitants of the planet staring into the chasm of injustice and poverty. By incorporating the goals in the short and long-term plans of each municipality, region and nation, it will be possible to divert the current development trend towards a fairer economy of benefit to all citizens, flora and fauna. **Epidemiological studies** demonstrate that equality is essential to a host of physical, mental, and social health outcomes. Societies that are more equal have lower rates of infant mortality, homicide, imprisonment, teenage motherhood, and other indicators of economic dysfunction. People in those countries also have higher life expectancies, levels of literacy, math proficiency, social trust, social mobility, and other positive signs of a healthy society (World Inequality Report 2018).

Should Equity Be a Goal of Economic Policy?

Over the past decade, global output has grown by more than 3 percent a year and inflation has slowed in most regions. However, the fruits of this growth have not seen equal share outs and income disparities have grown in many developed as well as developing countries. One of the most pressing issues facing policymakers today is how to respond to these trends. To what extent are growth and equity complementary, and to what extent is there a trade-off between the two?

Why Is Equity Important?

The answers to these questions depend on how equity is defined. Different societies have different perceptions of what is equitable, and these social and cultural norms shape the policies they will adopt to promote equity (IMF working paper).

- Policies that promote equity can help, directly and indirectly, to reduce poverty. When incomes are more evenly distributed, fewer individuals fall below the poverty line. Equity-enhancing policies, particularly such investment in human capital as education, can, in the long run, boost economic growth, which, in turn, has been shown to alleviate poverty.
- Heightened awareness of the discrimination suffered by certain groups because of their gender, race, or ethnic origin has focused attention on the need to ensure that these groups have adequate access to government services and receive fair treatment in the labour market.
- Many of today’s policies will affect the welfare of future generations, which raises the issue of intergenerational equity. For instance, the provision of very generous pension benefits to today’s retirees could be at the expense of tomorrow’s pensioners -an important issue in many transitional and industrial countries.

One of the measurements of equity is the Ginni coefficient. In economics, the Gini coefficient, sometimes called the Gini index or Gini ratio, is a measure of statistical dispersion intended to represent income inequality or wealth inequality within a nation or any other group of people.
The Gini index measures the degree of inequality in the distribution of family income within a country. The more equal a country’s income distribution, the lower its Gini index, *e.g.*, a Scandinavian country with an index of 25. The more unequal a country’s income distribution, the higher its Gini index, *e.g.*, a Sub-Saharan country with an index of 50. If income were distributed with perfect equality the index would be zero; if income were distributed with perfect inequality, the index would be 100.
One of the examples is how the tax system affects the distribution of income. Looking at change in income

distribution before and after taxes and transfers is one way to gauge the extent to which taxation and public spending contribute to redistributing resources among individuals within a country. The following two visualizations show this, by comparing the degree of income inequality (Gini coefficients), before and after taxes and transfers.
The static chart (Fig. 1.1. 11) gives an overview across all OECD countries using the available estimates from 2012-2014. The interactive chart relies on the same definitions and data sources.
As we can see, taxes and transfers do reduce inequality significantly: in all countries there is less inequality after redistribution takes place via taxes and transfers. Interestingly, however, the achieved reductions in inequality vary considerably between countries, and substantial cross-country heterogeneity in inequality remains after redistribution.

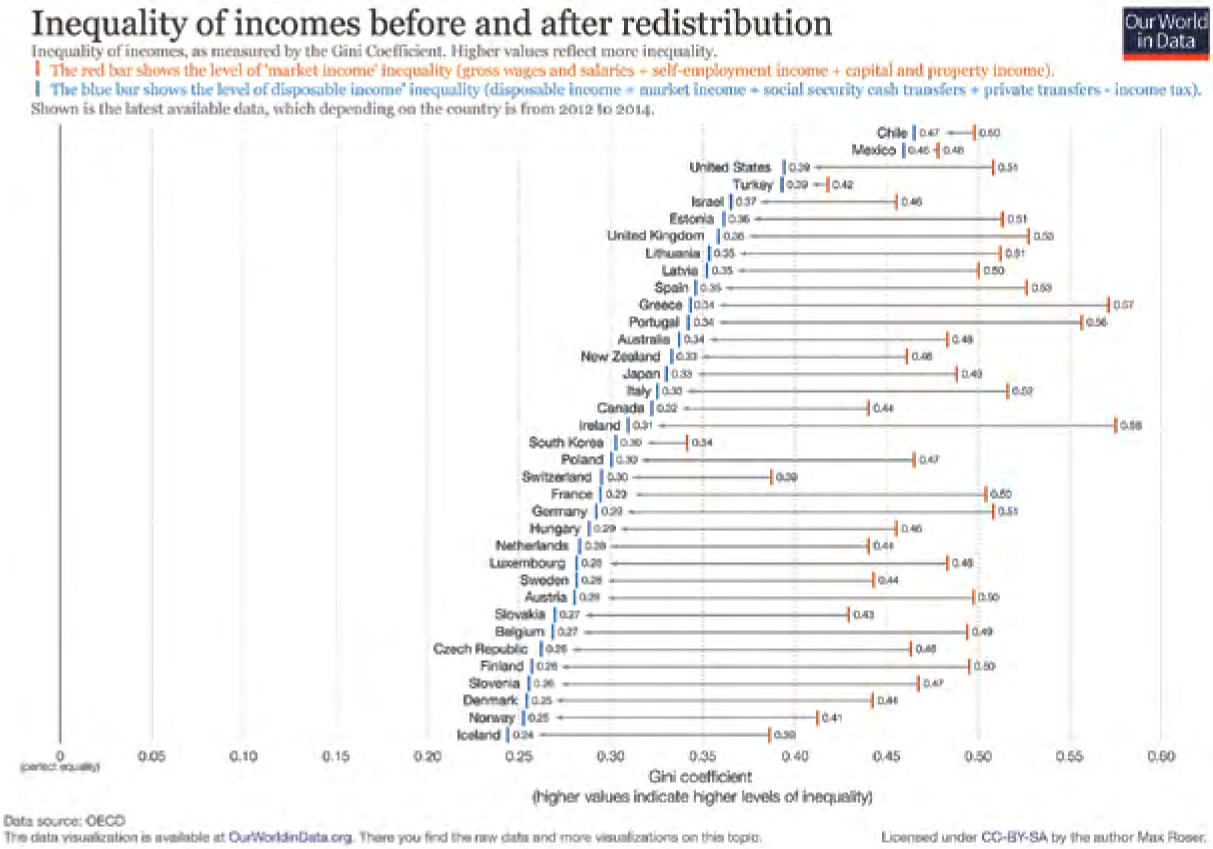

Figure 1.1.11. *Inequality of Income*

Over the last decades, a large body of theoretical and empirical research has attempted to determine whether inequality is good or bad for economic growth.
From a theoretical point of view there are arguments in both directions. Inequality will possibly lead to less economic growth via political instability and social unrest. But it may also lead to more economic growth via higher incentives for people to make productive investments.

10 Economy

By Doriana Matraku Dervishi, Ivan Šulc, Naomi Morishita-Steffen, Martin Brown

Regenerative economics is an economic system that works to regenerate capital assets. A capital asset is an asset that provides goods and services that contribute to our well-being. Regenerative Economics focuses on the planet and the goods and services it supplies. (Kibert, 1999) A Regenerative Economy maintains reliable inputs and healthy outputs by not exhausting critical inputs or harming other parts of the broader societal and environmental systems upon which it depends. It is a product of human and societal vitality, rooted in ecological health and the inclusive development of human capabilities and potential. (Cost Restore, 2017)

The Pre and Post Pandemic Economy

Natural systems around the world have been showing signs of extreme stress over the last 50 years. Yet, the deterioration of natural systems has disjointed the current economic model that is too attached to and dependent upon constant annual growth. Looking at the traditional metric of GDP growth, strains are globally visible. The total number of business insolvencies globally were expected to increase on average by 6% in 2020 at the beginning of the year (Allianz SE, 2020). Asia led the trend for global bankruptcies (Lemerle and Subran, 2020). The global economic situation had already been slowing over the past four years. The 9% year-on-year rising trend for business insolvencies was increasing before the pandemic and its global contagion began towards the end of 2019.

As the pandemic spread globally, the economic forecast was a contraction of 6% with one pandemic wave. If a second pandemic wave hit, the OECD predicted that the economy would shrink by 7.6% on average, decimating any projected gains (OECD, 2020).

The Covid-19 pandemic drastically changed the global economy in all aspects of daily life. Leaving not only the stability and the vulnerabilities of our society exposed, but also the strengths and weaknesses of our economic systems.

Economic health is strongly related to the health of the planet. Current economic growth builds upon the exploitation of natural and human resources to the benefit of a handful of people, in comparison with the people needed for their exploitation. By replacing labour with AI-driven machines that learn through complex algorithms, wealth concentration can accelerate even faster, trapping ever higher numbers of inhabitants on the planet within the chasm of injustice and poverty.

Since time immemorial, people have moved to the city, in search of a better life. For the millions who left their homes to move to the city, hope for a better life still prevailed. Cities look attractive: everything you need is within reach. The benefits of concentration are partly offset by costs. Living in urban areas is almost always associated with high housing costs and high population density often causes nuisance and annoyance. Especially so for the poorer part of the population, that is most affected by noise, pollution, vandalism and has a less healthy living environment.

If the balance of benefits versus costs is positive, the concentration of people and activities will increase. If the balance is negative, then costs outweigh benefits and those involved have to choose. This ever-changing balance makes cities look alike, but is also the main cause of their differences (smart city hub). The continuous movement of people from within New York is characteristic for all major cities. It also applies to Amsterdam, Copenhagen and Barcelona, cities with a progressive image but a persistent lack of affordable housing. People whose rent or mortgage is no longer affordable move to other parts of the city, to the suburbs or drift to smaller urban centres. A substantial group that follow no other options and can no longer pay their housing costs face eviction.

Economic growth (Axford 2019) remains a political and economic priority in almost all countries. Growth that is measured easily by adding up the total amount of financial resources that is spent from year to year. Mainstream economic thinking assumes that demand will always grow and that, in an effort to meet this demand, firms will deliver an increasing amount of goods and services, resulting in never-ending economic growth. In this vision, growth is the main goal of a successful economy and the measure of its success.

As early as 1968, Robert Kennedy stated in a speech at Kansas University: *Gross National Product counts air pollution and cigarette advertising, and ambulances to clear our highways of carnage. It counts special locks for our doors and the jails for the people who break them. It counts the destruction of the redwood and the loss of our natural wonder to sprawl*. Fifty years later, the ecological and social effects of the dominant economic model are more visible than ever.

In 2017, the governments of Scotland, Costa Rica, Slovenia and New Zealand within a new alliance signed the Wellbeing Economy Alliance. Costa Rica is among the top three countries in the world for the well-being and happiness of their people. The government of New Zealand no longer accepts GNP as the supreme measure of progress: *We need to make sure we are looking at people's ability to actually have a meaningful life, an enjoyable life, where their work is enough to survive and support their families*, the prime-minister said.

A growing group of people are realizing that the world needs a kind of prosperity that satisfies the needs of the entire world population – now and in the future – and comes about in a socially and environmentally sustainable way (SmartCityHub).

Policies for responsible growth

In the first place, there are the UN *Sustainable Development Goals*, followed by the concept of a *doughnut economy* proposed by UK economic scientist Kate Raworth, and finally the *Green New Deal* in the US.

The model that is used by different countries, to front the effects of Covid-19, is the "doughnut economy". The World Economic Forum describes the case of Amsterdam, explaining why this model fits very well in this situation.

> Doughnut planning seeks to balance the needs of people and the environment.
> Amsterdam aims to offer everyone fair social terms within safe ecological limits.
> The idea was conceived by Kate Raworth, an Oxford University economist.
> A shortfall of investment in climate action will be a key risk as the world emerges from COVID-19.
> But there is also an opportunity to incorporate sustainability in future plans.

Amsterdam – An application of Doughnut economy model

Amsterdam is embracing the doughnut, (Fig. 1.1.12) an economic model that foresees "a world in which people and planet can thrive in balance". The idea behind the doughnut model is simple. If you only look at the shape of a doughnut, you see two circles. A small circle in the middle and a large circle on the outside. The smallest circle represents the minimal social objectives (basic-needs) that apply to each country. The large circle represents the self-sustaining capacity of the planet. All societies must develop policies that stay between the two lines. Where economic behaviour nowadays has far-reaching consequences that go beyond both lines, future economic policy must aim to make societies thrive between the lines.

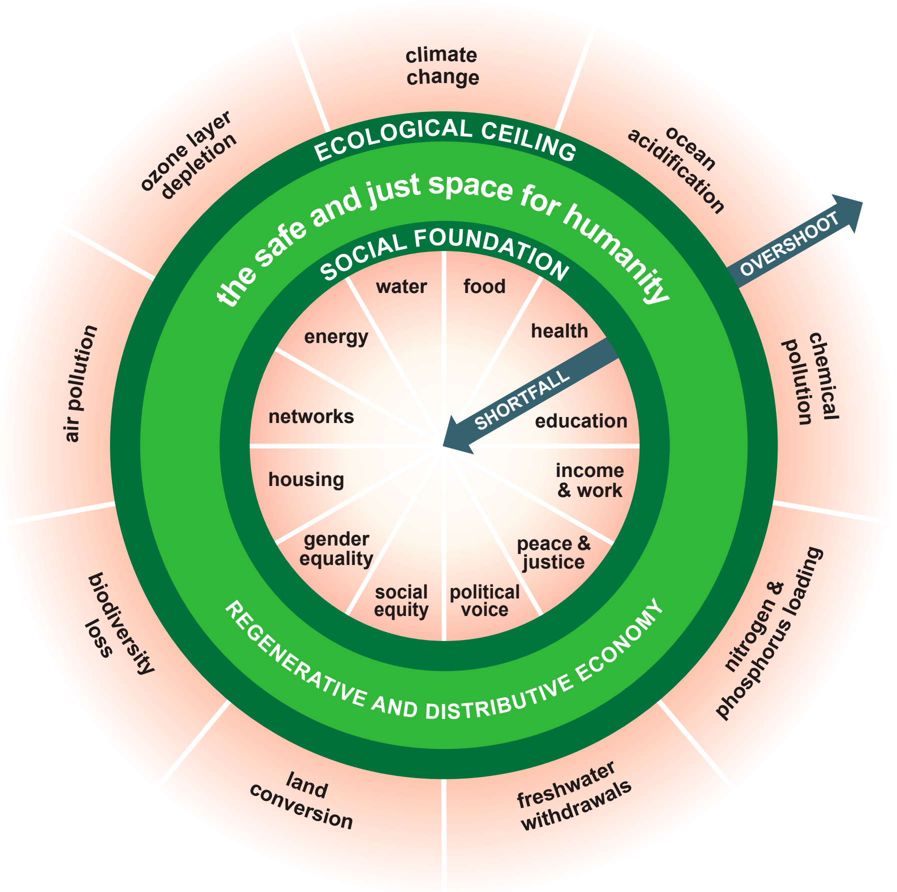

Figure 1.1.12. *The Doughnut of social and planetary boundaries. Kate Raworth and Christian Guthier. CC-BY-SA 4.0 (Raworth, K 2017).*

The Green New Deal

It is already ten years since the United Nations called for a 'Global Green New Deal' in which developed countries would invest at least 1% of GDP on reducing carbon dependency, while developing economies should spend 1% of GDP on improving access to clean water and sanitation for the poor as well as strengthening social safety nets.

Regenerative economy through tourism

Tourism is a growing industry that in 2019 achieved 1.5 billion international tourist arrivals in the world. The UN 2030 Agenda recognizes the benefits of tourism under Goals 8, 11, 12 and 14, aimed at promoting tourism as a means of increasing employment and economic growth, as well as to value and protect heritage. Socio-economic impacts of tourism in cities are visible from the level of individual buildings to whole urban regions. At its lowest level, tourism contributes to restructuring old buildings by converting individual properties into apartments for rent to tourists (via Airbnb, Booking or other platforms) or whole buildings into hotels, as well as opening new business (*e.g.*, bars, restaurants, laundry services, souvenir shops...). Converting lofts to apartments often provides co-owners financial sources for renovating and improving the buildings and increases their value and appeal (*e.g.*, static reinforcement, thermal façade and windows, new roof, installing an elevator), as in many European cities (*e.g.*, Vienna, Prague, Krakow). Rising prices of renewed and existing residential real estates, however, make those apartments available only for more well-of residents and potential entrepreneurs.

These processes are particularly visible at the neighbourhood level, particularly in urban centres and surrounding areas, as well as in those with a special sense of place (*e.g.*, the example of Barcelona) and/or well connected by public transport (*e.g.*, Brooklyn within New York). Tourism can with quality urban planning be used for the regeneration of decayed neighbourhoods and the diversification of economy and social life (*e.g.*, new restaurants, bars, grocery stores, recreation facilities, events), particularly in former commuter neighbourhoods. Income from tourism is invested in heritage preservation, as well as infrastructural development (playgrounds, parks, public areas, public transport, services etc.), from which all residents and visitors may benefit. The best results are achieved, if accommodation is offered in small- and medium-size hotels, mostly scattered around the city, with a few in restored heritage buildings within the centre. This way tourism helps to restore the historical centre by maintaining its character as a living place. However, while owners may benefit from higher property values, potential buyers cannot afford to live in those gentrified communities and move away to other peripheral districts (*e.g.*, Barcelona).

Quality management on the city level can use tourism as a generator of economic development and diversification and to attract new investments by creating a positive market image. Diversified structure makes the urban economy robust and less vulnerable to localized crises, particularly if it relies on innovative private business and small and efficient public services. Tourism in a city with a diversified economy brings multiple short-term and long-term, visible and intangible economic benefits, *e.g.*, higher incomes for the local population, new jobs and increasing employment, upgrading the structure of economic activities, increasing entrepreneurial activity, providing financial support for preserving nature and cultural heritage attractions etc. (Mason, 2003; Page, 2009; Šulc *et al.*, 2020). A good example of tourism-led regeneration of the city is Amsterdam, where tourist sites are built into the architectural and cultural fabric of the city, where flexible small-scale leisure economy prevailed over large reconstruction plans and converting the historical centre into the Central Business District (Terhorst *et al.*, 2003).

However, urban destinations that lack quality management and planning, often experience negative impacts of tourism, such as over-dependence upon tourism, particularly high during crises, high seasonality in tourism demand and economic activity, excess of low income jobs that require low-skilled workers, growing economic inequalities between owners of tourism businesses and other residents, decline in traditional or competing economic activities (*e.g.*, industry), increased prices of goods and services, resulting in a lower acquisitive power for residents (particularly those not involved in tourism) (Mason, 2003; Page, 2009; Šulc *et al.*, 2020). In popular heritage cities these processes can lead to *overtourism*, a phenomenon when tourism overtakes the local economy, exceeds the carrying capacity and starts causing negative effects for all parties (local community, non-tourism economy, tourists…) (see Responsible Travel, 2019). The best example is Venice, used as a prototype of the Russo (2002) *Vicious Circle of Tourism* model, which describes a tourism-led transformation of a living heritage city to an open-air museum completely oriented towards same-day visitors.

Urban reliefs of touristic cities yield better analyses of tourism impacts, as these are usually representative of areas of interest for same-day visitors visiting the city core, where tourism accommodation is offered (*e.g.*, Dubrovnik), unlike the areas from which a city work-force is supplied, as well as agricultural and manufactured goods for tourism consumption. In these cases, indirect and induced tourism expenditure is mostly kept within the urban region, softening any economic leakage. The suburban fringe usually only experiences economic benefits from tourism, as it requires lower costs (compared to the core city) (Russo, 2002). Tourism increases income and living standards for all residents working in tourism, though there are others who profit from increased economic activity in general. Hardly restraining other economic activities, sustainable tourism stimulates them; and through quality urban planning compacts it connects regional development, reducing economic inequalities between the city and its region (Šulc *et al.*, 2020).

11 Scale Jumping Interventions

By Martin Brown

HUMAN	> Application of Bio-Leadership principles > Application of Regenerative Mindsets (SEVA)
DESIGN	> Decarbonisation through design > Ecological harmonization of our built environment through biophilic design approaches > Biophilic design of technologies embedded in the built environment - technologies in support of nature and healthy life > Ecological, cultural and social applications of a Living Building framework and standard. > Understanding architecture as spatial media - designing space as lived experience and avoiding placelessness.
PLACE AND SPACE	> Elevate the sense and importance of place as a special and unique combination of environmental and cultural characteristics of a location
NATURE	> Implement Nature Based Solutions at large city scale and surroundings > Improve accessibility to parks and green spaces > Prioritize “human scale” in designing human-centric rather than car-centric cities
ENERGY	> Promote Positive Energy Districts and facilitate their implementation using tools like energy cafes and living labs > Consider the human-centric (based on eMergy) approach when assessing different urban solutions > Integrate materials and technologies into building envelope to produce energy and increase indoor comfort > Developing innovative technological solutions to the micro and macro scale improving the wellness and reducing the human environmental impact of PEB and PED
MATERIALS	> Use Toxic Material Red Lists and Material Transparency labels outside of sustainability building standards > Promote bio-based materials, whilst decarbonizing core building materials > Increase education in climate and carbon literacy across all built environment sectors.

EDUCATION	>	Elaborate new indicators to ensure that Higher Education can play its leading role in the transformation towards regenerative sustainability and its well accounted and prioritized in financial plannings.
	>	Those exercising leadership functions should adopt servant leadership in the academic world, governed through collaboration rather than in a competitive spirit.
	>	Networking among all of the experienced organizations, teachers, businesses that hold important skills and experience to contribute to capacity building, to get people involved and become active healers of the Earth
EQUITY	>	Address equity, equality and social justice issues in all aspects of the built environment including rights to natural elements (views, light, air, water)
	>	Ensure representation of nature and natural features (land, rivers) across built-environment processes as a stakeholder with increasing legal status
ECONOMICS	>	Promotion, education and application of regenerative economic literacy (such as the doughnut model) across all areas of the built environment
	>	Embed Social Justice in all economic considerations
	>	Embed Nature based accounting in all economic considerations

VITAL SCALE JUMP INTERVENTIONS

Application of complexity theory thinking and distilling the pattern of interventions down to three simple rules, provides a simple but vital set of rules for Scale Jumping towards a regenerative built environment

DECARBONIZE EVERYTHING within the built environment,

HEAL THE FUTURE repair past damage, enable eco systems to thrive through a connected with nature Seva mindset,

CLIMATE + ECOLOGY LITERACY improve the awareness and knowledge of climate and ecology throughout all aspects and sectors of the built environment, on a par with language and cost literacy.

12 Conclusion

By Martin Brown

We cannot effectively change the built environment around us unless we scale jump from the few to the many, from the few regenerative materials, buildings and cities, to all. But to do so we need to change the mindset and lens through which we view the world. (Brown, M 2020) (WG5 TS Keynote)

It is only through a deeper understanding of our connections as part of nature where we see ourselves and our built environment as part of the ecosystem that we will be able to truly move from degenerative to regenerative practices.

This move will require a new level of consciousness with an enhanced sense of self, that we cannot, as humans, thrive or even survive alone, that our future, will be shaped and determined by a symbiotic future that works for the Earth and all life.

This mindset, by necessity, will have to permeate across all aspects of our built environment as explored and defined within the work of RESTORE (Cost RESTORE) and in this chapter's perspective papers, articles and essays.

We are on the cusp of a transition to a new paradigm and a new era of regenerative sustainability, driven by a number of factors including the deepening acceptance of contributions from the built environment to our climatic and ecological crisis, both as a problem and as a solution, and as we move into an era of living with Corona virus.

In the words of Arundhati Roy, we are passing through a portal that presents a totally unique opportunity for progress to a regenerative future …

> Historically, pandemics have forced humans to break with the past and imagine their world anew. This one is no different. It is a portal, a gateway between one world and the next. We can choose to walk through it, dragging the carcasses of our prejudice and hatred, our avarice, our data banks and dead ideas, our dead rivers and smoky skies behind us. Or we can walk through lightly, with little luggage, ready to imagine another world. And ready to fight for it.
>
> (Arundhati Roy, 2020).

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The interrelated complexities within a typical city,
© Opportunity Peterborough, 2018

1.2

Scale Jumping: Human – Built Environment Interactions

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TABLE OF CONTENTS

Summary

The following sections explore the relationships between people and the built environment for scale jumping. The chapter presents guidelines with best practice examples for policymakers and developers and different ways of interpreting scale jumping to meet climate neutrality goals. In doing so, it clearly illustrates the relations between concepts and actual implementations, and local factors such as co-creation for the inclusion of citizen participation. Different factors and interactions will be defined in the first section, in view of the many and varied ways to jump in scale. It begins with an exploration of the overall contextual considerations and how scale jumping may be considered within the Restore Project. In the second section, district-level innovations implemented within three different Lighthouse Cities (LHC) will be illustrated as part of the Smarter Together case study. All project partners benefit from an open exchange with stakeholders from academia, local government, local citizens, and innovative SMEs. The relationship between health and the built environment with the essential factors for scale jumping will be explored in the third section. Several international building assessment tools and their relations with Human Building Interactions will be described in the last section, giving special consideration to the impacts of building quality on human health and healthy indoor environments.

1 Defining Scale-Jumping Interactions Relating to the Human-Built Environment

By Naomi MORISHITA-STEFFEN, Mihaela HĂRMĂNESCU and ZVI WEINSTEIN

1.1 Introduction

The definitions outlined in this section build upon the developments from the previous Restore publication (Brown *et al*., 2017) that updated our sustainable vision to go beyond making the most minimal negative impact on our built and natural environment to new types of restorative and regenerative sustainability, where people, nature, and the built environment co-exist in harmony and flourish together (Figure 2.2.1). The first publication defined sustainability in terms of restorative and regenerative sustainability (Brown *et al*., 2018). The second volume outlined "Regenerative Design in Digital Practice" (Naboni *et al*., 2019). The third set of guidelines illustrated the application of regenerative design in "Regenerative Construction and Operation" (Peretti *et al*., 2019), while the fourth handbook preceding this publication summarized "Regenerative Technologies for the Indoor Environment" (Lollini *et al*., 2020). The set of all four guidelines are available on the Cost Restore website at https://www.eurestore.eu/publications-and-articles/.

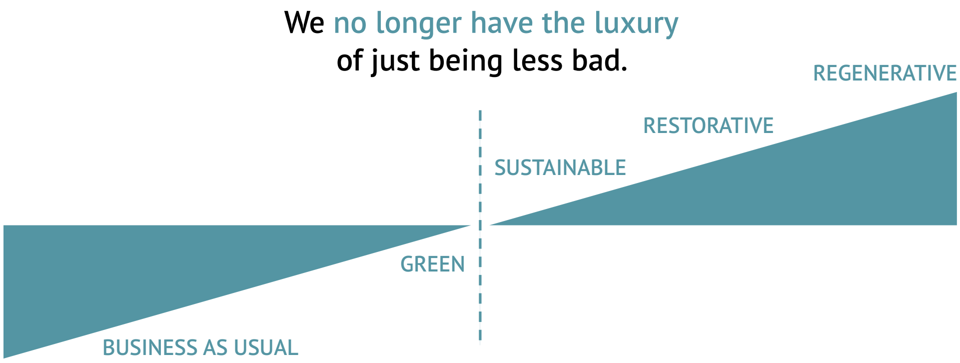

Figure 1.2.1. *The RESTORE sustainability vision (Brown, et al., 2018).*

It is necessary to implement all the findings in all Restore volumes simultaneously, but, at different scales to reach self-sustaining environments that co-exist in harmony with nature. In this section, the actions taken at district and municipal levels relate to impacts at national, continental, and global scales.

1.2 Climate Emergency

One thousand seven hundred and fifty-one jurisdictions have globally declared a climate emergency (Aidt, 2020). The list includes the European Union, nations, regions, and local authorities. A climate emergency implies that a government body has acknowledged that its environmental legislation is presently insufficient for slowing the rate of climate change, and that legislation must be amended to mitigate climate change (Gills and Morgan, 2020). The Oxford Learner's Dictionary defines a climate emergency as "a situation in which immediate action is needed to reduce or stop climate change and prevent serious and permanent damage to the environment" (2020). In this publication, we follow different paths to achieve solutions that can address the current climate emergency on a large scale by scale jumping. Each solution quantifies the impacts to contribute to municipal, regional, national, EU, and global climate neutrality goals.

1.3 Carbon Neutrality

As a response to the climate emergency, municipalities, federal governments, and the EU have set the goal of reaching carbon neutrality as part of their climate protection plans. The target dates to achieve carbon neutrality range from 2030 to 2050 in accordance with the UN IPCC Paris Agreement that defined climate neutrality as "net-zero emissions of greenhouse gases by 2050". The original target is from the 2015 international Paris Agreement that set the global target to limit global warming by 1.5 °C (European Commission, 2018).
Strategies to reduce the human impacts on reaching carbon neutrality through our combined interactions with the built environment at a municipal level form part of the scale-jumping efforts of Working Group 5. Approaches to reach carbon neutrality include planning for regenerative districts and equitable neighbourhoods using a systems approach.

1.4 The Restorative Approach

The aim is to reintegrate natural systems in district and municipality regenerations for all citizens and urban populations. Our goal is to define different paths to move beyond our traditional borders and to scale-jump beyond established norms. The definitions in this chapter refer to key concepts primarily for Chapter 5.1.2 on the subject of Human-Built Environment interactions, but it also relates to the entire Transactions Section of 5.1 outlining interactions between nature, the built environment, and people.

1.5 RESTORE Scale Jumping Developments in Working Group 5.1

The relations between the definitions in this section concern the interactions between people and the built environment. The definitions reflect a cumulative process building upon the foundational concepts developed from the previous Restore volumes and the developments within all sections of 5.1 that are addressing the interactions between people, nature, and the built environment for scale jumping. Figure 1.2.2..2 shows the relationship of the definitions to the previous and current developments within the Restore project.

RESTORATIVE APPROACHES TO SCALE JUMPING

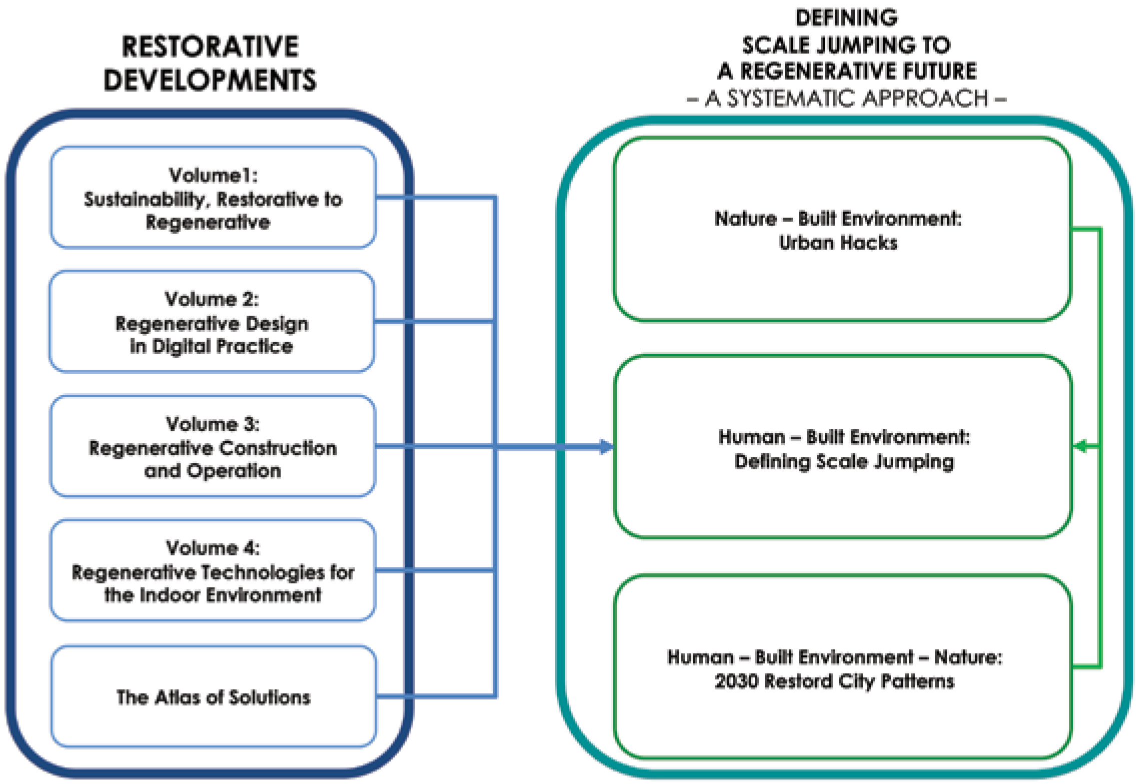

Figure 1.2.2. *Concept development for defining scale-jumping in relation to human-built environment interactions within Restore.*

Scale jumping is defined in different ways in Working Group 5. In 5.1.4, the interactions between nature, the built environment and people are considered within the Restord City of 2030 that is scale jumping in **time** to the Year 2030, envisioning a new city where the principles of the restorative economy are applied to regenerate sustainability.

Municipal case studies illustrate how local metropolitan areas are scale jumping **beyond their municipal borders**. Cities, towns, and villages can implement state of the art innovations through collaborations such as the EU Horizon 2020 Smart Cities and Communities and EU Interreg frameworks. Within each framework, municipalities can form productive partnerships and exchanges with other European and non-European communities based on the best research concepts and theories from universities and colleges. The diverse involvement of different stakeholder groups has brought together academia, research, industry, local government, and local citizen groups to regenerate city districts and regions. Through collaboration, each municipality learns to appreciate the perspectives of the other stakeholders in the projects and how working together is the key to implanting innovative solutions for a regenerative future. This work can be considered as scale jumping to a **continental or international scale** because the projects connect cities and regions within Europe and internationally.

1.6 Ego, eco, seva

Ego, eco, seva has been a principle throughout the Restore project. The goal is a change of perspective starting not from our egocentric selves (ego), but moving towards ecological solutions (eco), and ultimately reaching the regenerative philosophy where we humans re-establish harmony within nature including our built environment (seva). To do so, consideration of the local human impact needs to be related to the entire natural system on a global scale using a systems-thinking approach. Rather than linear processes, impacts and systems must be considered as networks responding on multiple levels. This mindset change is necessary for effective regenerative change (Brown *et al*., 2018).

1.7 Scale Jumping

The global changes that are currently taking place must of course be considered in the steps for scale jumping of the human-built environment. The following list describes the set of actions that have been suggested both for citizens and for governments:

1. Recruiting technology to cope with nuisance in both the human and the built environments;
2. Inclusion of disadvantaged societies;
3. Engaging worldwide partnerships to find the best ways to move towards significant improvements for the global population;
4. Changing old concepts and paradigms which do not fit the new global situation;
5. Using the concept of virtual circles: i.e., to find connections > factors > interactions > outcomes to problems or topics that have the means and tools to bring positive changes to society;
6. Using approaches such as the restorative economy, regenerative economy, circular economy, managing tools, building tools that consider human aspects such as LEED, BREEAM, WELL, etc.; and,
7. Giving priority to greening cities and open neglected spaces.

1.8 Defining Scale Jumping from a Human Perspective

Human-Built Environment

The Human-Built Environment is a network of direct and indirect connections that establish new pacts between human beings and the built environment components that are composed of our near and remote surroundings. The network is wide, and it varies from place to place. It is complex and changes its characteristics.

The Human-Built Environment is based on ecosystems sometimes controlled by human beings and sometimes influenced and impacted by *force majeure*, beyond the control of human beings such as climate change, storms, floods, political decisions and interventions, geopolitics, mass migration, etc.

Human-Built Environment relationships cover every aspect of our life cycle and we must maintain the law of inertia, so that our environment may remain free from negative and external influences.

Since further urbanization is expected to continue throughout the world, we must inspire and strive to reach the sort of city that will incorporate current developments and integrate them into future developments that honour Sustainability, Liveability, Citizenship, Intellectuality, Attractiveness, Technology, Sci-

ence, Education, Artificial Intelligence, Community. Ecological balance, Circularity, Citizen-Centric, Common Spaces, Biodiversity, Nature, Equity, Justice and Equality within the CITY.
If, on the basis of the above aspects and features of a city, we will ever be able to guide cities/metropolitan areas towards co-design, co-creation, co-planning and co-development of cities, then the HUMAN-BUILT ENVIRONMENT will achieve the aspirations of the RESTORD 2030 ideal.

Could the world be united in this long-term mission?

Human and the Built Environment

We have to analyse the composition of the topic itself to find appropriate and suitable definitions for its three components: 1. Human; 2. Environment; 3. Built Environment. Each one is an ecosystem in itself but has very close relationships with the other two components to complete a comprehensive and meaningful structure.
Three components that undoubtedly have very strong interactions between each other. The bonds between human beings and their surrounding environment have evolved in parallel over millions of years. We have witnessed constant developments throughout such a long timeline and many changes dependent on such factors as population growth, urbanization processes, industrial and agricultural revolutions, technological innovations, wars, resource exploitation, colonization, global economic development, and scientific educational and medical innovations, amongst many others.
Continuation of these complex interactions depends on the development of human beings towards well-being, achieving tools and solutions for the benefit of humankind and to enable prosperous activities for the common good.
Human beings hold the power to plan, create, design, construct, maintain, control, judge, produce, shape, destroy, change, exploit, use, build, educate, innovate and the list could go on almost forever. These actions and many more are aimed at building a society that will nourish, maintain, and sustain the long-term benefits of the environment.
The purpose is to construct a valuable built environment to meet standards for quality of life, and equal rights for all human beings, regardless of gender, religion, belief, colour, culture, socio-economic status, and social differences and to supply, at least, the basic needs for housing, infrastructure, community services, open spaces, access to health care, food and water, and technological tools.
The following section provides a wider perspective of the (revised) list of items and terms gathered together in relation to the three components that constitute the topic of the human and the built environment. These components are divided into several subtopics: policy, environment (indoor), environment (outdoors), community, technology, place, and active transportation.

Policy

This subtopic is a very significant priority for decision makers and local/central governments. It is impossible to adopt a human-built environment ecosystem without discussing the policy issues that will take place and influence both human beings and the environment.

These are points to be taken into consideration:

Superblock policy:
A policy adopted by the City of Barcelona in one of its neighbourhoods as “tactical planning”, to experiment with the partial pedestrianization of streets for use by all residents.

***Social Planners**:*
This is one of the most important functions when designing and planning a neighbourhood. The social aspect of a comprehensive plan has positive impacts, strengthening the bonds between citizens and their sense of belonging to the place.

Health Education:
An essential value for human beings from the first day of birth. Adopting healthy habits is a preventive step so as not to contract disease in the future.

***Economic Plan**:*
To serve as a mobility factor for people’s employment, income, financial security, and for payment of taxes to improve local infrastructures.

Trusted Leadership:
Leadership with a commitment to fulfilling the long-range vision of the city is entitled to broad support from the local administration.

***Land Use**:*
The most important tool for planning the utilities and functions in a neighbourhood/ city/region. It shows the details of the place, its layout, functions, division into sections, transportation, and open public spaces.

Public Health:
The extent to which individuals maintain their personal health and are together representative of the common state of health or public health. Healthy individual lifestyles inspire others to establish a healthy society that needs less medical care.

***Bureaucracy**:*
The planning process depends on the approval of local government departments such as water, electricity, roads, security, and building.

Green building:
Green building is the solution to the global climate crisis, the over-exploitation of natural resources, the use of renewable energy, the impacts of the built environment on communities, and the enforced changes in thinking to confront and to overcome negative influences on human co-habitation.

***Multidisciplinary Approach**:*
Achieving excellency in planning not only needs skilled planners, but also additional expert roles, and consultative processes with all stakeholders to shape rational, sustainable, regenerative, and resilient plans. A multidisciplinary approach is therefore necessary.

Health services:
A variety of functions come under this heading, including hospitals, clinics, food security, childbirth, nutritional education, maintaining public health and safety, and interconnectivity between health and the built environment.

***Environmental planners**:*
Environmental planning is a significant function, especially during the climate change crisis where efforts are focusing on countering desertification, drinking water scarcity, excessively high temperatures, and rapid population growth in urban centres.

Indoor Building

The indoor building environment is one of two issues that impact human beings who spend many hours inside their apartments, houses, and at their place of work.

***Building materials*:** The human health factor becomes the primary reason to find new ways of reducing negative health impacts and increasing the use of green building materials. Buildings produce high levels of carbon dioxide through the production process of building materials and during the lifespan of the building.	***Water quality:*** Dirty water persists as the main cause of vulnerability to malaria, typhus, and other deadly diseases among large populations.
Dwelling density: Explains the negative health impacts on tenants who live in high-density housing that large populations living in small apartment spaces often show.	***Sanitation*:** It is the basic standard that has to maintained to prevent health deterioration. Lack of proper sanitation is the most dangerous element preventing good healthcare.
Chemical materials: Chemical materials are ubiquitous. We may inadvertently ingest chemicals through inhalation, food consumption, or by living adjacent to industrial zones producing smoke and pollution. Chemicals are hazardous materials that can provoke serious harm to the body and even disease.	***Dust and pests:*** Both have direct impacts on human health. Dust and pests infiltrate everywhere, whether in homes, offices, or public buildings. Dust and pests, as reservoirs for chemicals, allergens, and heavy metals, can cause breathing and skin complaints.
Views outside the building: Natural landscapes, water, flowers, and gardens have positive impacts on human wellbeing and relaxation.	***Moisture:*** Mould growth caused by excessive moisture levels in buildings (over 80 % relative humidity) can cause serious health problems such as asthma and lung complications. Therefore, it is necessary to address the moisture problems at its source by drying or replacing contaminated building materials; or using other methods to remove mould.

Noise:
Noise influences the human mind and thinking processes, ability to learn, and disturbs hearing. Background noise should be limited to a maximum of 35 decibels in workplaces.

***Ventilation**:*
Ventilation exhausts indoor sources of odours, chemicals, and carbon dioxide. Fresh air supplies should provide filtered air. Recirculated air supplies should have a minimum extraction efficiency of 75% for all particle sizes including nanoparticles.

Indoor air and environmental quality:
It is crucial to maintain healthy indoor environmental quality by routinely conducting air quality tests, and by regularly addressing occupants' concerns.

***Thermal health**:*
Minimum thermal comfort levels reach thermal health levels when temperature and humidity, and deep thermal conditions are consistent throughout the day.

Outdoor Environment

This is the second list of issues that are troublesome to human beings. Missing only a few of these items in a nearby built environment can have detrimental consequences on human wellbeing.

Green public places:
Open public spaces in the city benefit the general public who use green spaces for leisure activities with their families and outdoor sports activities.

Construction & demolition waste (CDW):
CDW produces multiple types of land pollution and simultaneously provides resources for a circular economy.

Industrial zones:
Light and heavy industries located close to or far from residential areas are an essential economic factor for city development. Industrial zones provide employment, essential services, and are a source of tax revenue for both local and central governments.

***Place making**:*
An approach to beautify neglected places within neighbourhoods and cities through reuse for the wellbeing of residents.

Brownfield:
Brownfields are neglected areas where heavy industry and coal mines were previously active. They are basically contaminated land polluted by radio-active materials, and other polluted soils that are unfit for human use.

Pollution:
Pollution is one of the worst factors impacting both on the environment and on human beings. A variety of sources pollute producing smog, smoke, and noxious emissions from cars, heavy industry, factories, and landfills.

Urban nature: An approach born as a way coping with health spots in the city, minimizing CO_2 and pollution.	***Dust:*** See Dust and Pests above.
Flammable waste: One of the many outcomes of dumping Construction and Demolition Waste (CDW) in open spaces and not in authorized landfills.	***Climate change***: The most significant issue that the world is facing to cope with warming temperatures, floods, tsunamis, storms, extreme precipitation fluctuations, and desertification processes.
Greenhouse gas emissions: Lowering greenhouse gas emissions is one of the challenging factors influencing large populations. It has been prioritized as target for most countries around the globe.	***Physical infrastructure***: An all-encompassing definition of a list of items such as water, roads, transportation, and electricity that drive industry and national economies.

Community

The community sub-heading includes human elements and a diverse range of actors such as citizens, stakeholders, organizations, nations and governments, and all sectors (industrials, NGOs, international entities, academia, civic organizations, producers, and business, and agriculture, to mention but a few). The community is the essential life-force that can drive forward improvements, developments, innovations, and policies. Community is at the core of all future activities and decision-makers cannot afford to disregard the local community.

The collection of items listed below will be comprehensible to everyone whether a planner, designer, labourer, or otherwise. Understanding the terminology is the principal aspect to understand the connections between the physical, social, economic, and environmental aspects of planning and building programmes. Teams that consider these items and their meanings may succeed in building the most effective and beneficial plans for the wellbeing of human beings.

Connectivity	Education services
Accessibility to services	Social status
Self-responsibility	Resilience
Support	Leadership
Neighbours	Transparency
Bottom-up	Social workers
Partnership	Collaboration
Entrepreneurship	Youth

Place

The environment in its broadest sense may be found under this subheading, in other words both the natural and the built environments. Due to the importance of place, it is linked to terms that have a great impact on human beings. People design and build places. They are responsible for their economic and demographic growth, and individuals contribute to communal everyday life.

Sense of place	Culture
Belonging	History
Tradition	Values
Culture	Open spaces
Nature	Facilities
Making place	Citizen engagement
Place as classroom	Biodiversity
Food growing	Environmental education
Citizen science	Sustainability

Technology

In the world of rapid advancements and innovative developments, human and built environments should consider technology as one of the key tools for research, improvement, and innovation that impacts on human-built environment relations, and for the advancement within human beings themselves. The human world cannot enhance new improvements without pushing technology to the foreground. Thousands of innovations are designed and created every minute, aiming to change human quality of life in every aspect of life without exception.

Food-tech	Technological education
Digital health	Employment
Nutrition	Quality of life
Building improvement	Circular economy
Communication	Information
Big data	Innovation (e.g., IoT, Blockchain, Energy)

COVID-19 and the human-built environment

It is difficult to relate to COVID-19 without a full understanding what is and will be happening around us. The duration of the pandemic is still an unknown and many researchers and experts from a variety of disciplines have been seeking to understand the new situation and its impacts.

In these circumstances, we cannot predict what may happen tomorrow. Many changes are affecting the world and each country is to some extent confused over the best measures to take, caught between the dual pressures of the physical and economic health of its population, a veritable Scylla and Charybdis in which communities are making their voices heard on both sides of the divide.
A member of the RESTORE 5th Working Group, Zvi Weinstein, has participated in the international committee of the Pivot Group for Covid Recovery together with other experts. Active since April 2020, it functions as a thinktank for new ideas that are reportedly difficult to identify.
The committee is divided into several subgroups (including the topics of social sciences, infrastructure, energy, and water, although not medicine), none of which have been able to offer concrete strategies to mitigate the Covid-19 pandemic.
The Pivot Group has mainly been looking at socio-economic changes. The topics on the agenda are open/closed markets, unemployment, closure of companies and firms, development of a local rather than a global economy; urban farming/agriculture; and inequality between north and south.

1.9 Urbanism Definitions

Circular city

A circular city embeds the principles of a circular economy across all of its functions, establishing an urban system that is regenerative, accessible and abundant by design. These cities aim to eliminate the concept of waste, maintaining the highest values for assets at all times, and are enabled by digital technology. A circular city is one that generates prosperity, increases liveability, and improves resilience for the city and its citizens, while aiming to decouple the creation of value from the consumption of finite resources.
A built environment with a modular, demonstrative design, that sources healthy materials, will improve quality of life for all residents, and will minimize the use of virgin material. It will be built using efficient construction techniques, and will be highly utilized thanks to shared, demonstrative and modular spaces and housing. Modular building components will be maintained and renewed when needed, while buildings will whenever possible be used to generate, rather than consume power and food, by facilitating closed loops of water, nutrients, materials, and energy, to mimic natural cycles.

A circular city will be likely to include the following elements (Ellen McArthur Foundation, 2017):

1. **Energy systems** that are resilient, renewable, localized, distributed and that encourage active energy use, reducing costs and having a positive impact on the environment.
2. **An urban mobility system** that is accessible, ordered, and active. A multi-modal mobility structure that will incorporate public transport, with on-demand cars when required as a last-mile solution. Electrically powered transportation will be both shared and automated. Air pollution and congestion will belong to the past, and excessive road infrastructure will be converted to serve other needs of citizens. Central to vehicle design will be remanufacturing, durability, efficiency, and easy maintenance.
3. **An urban bioeconomy** where nutrients will be returned to the soil in an appropriate manner, while generating value and minimizing food waste. Nutrients could be captured within the organic fraction of municipal solid waste and wastewater streams and then processed to be returned to the soil as organic fertilizers – used for both urban and rural agriculture. Through urban farming, the city will be able to supply some of its own food, reusing food waste and sewage in closed and local loops to produce veg-

etables and fruits. Such a system could also provide a more resilient, diverse, and cost-effective energy system in the city through the generation of electricity from wastewater, biofuels and biorefineries. These will add revenue streams to the city, capitalizing on the utilization of materials and nutrients that are already in the loop.

4. **Production systems** that encourage the creation of 'local value loops', which implies more local production and increased and more diverse exchanges of value within local economies. Maker-labs (to encourage local production, repair, and distributive manufacturing), collective resource banks (to even out the demand and supply of materials) and digital applications (to broker the exchange of goods, materials, and services) will be central features within these local, circular production systems.

Circular Urbanism

A circular city should embed the three principles listed in the box 'How is a circular economy defined?' In view of the generic nature of those principles, the City of Amsterdam – one of the early adopters of the circular economy concept at city-level – developed seven principles to guide its transition:

1. Closed loops – all materials are infinitely re-used and recycled
2. Reduced emissions – all energy is generated from renewable sources
3. Value generation – resources are used to generate shared (financial and societal) value
4. Modular design – all products are designed in a modular and flexible way and system adaptability is foreseen at the production stage.
5. Innovative business models – all new implemented business models enable the shift from possessing goods to using goods through services.
6. Region-oriented reverse logistics – logistics systems are shifted to a more region-oriented service with reverse-logistics capabilities.
7. Nature systems upgradation – all human activities positively contribute to ecosystems, ecosystem services, and the reconstruction of "natural capital".

Circular urbanism transposes the principles of the circular economy to the land use by the city (Grisot, 2020) and offers a concrete alternative to urban sprawl. Furthermore, it is important that the transition occurs in all relevant sectors (Circular City Funding Guide, 2020).

Further information on circularity in cities is available from publications listed in the library (Circular City Funding Guide, 2020). Some specific examples are:

1. Circular Amsterdam by Circle Economy 2 (Circle Economy, 2015):
2. https://www.circle-economy.com/insights/developing-a-roadmap-for-the-first-circular-city-amsterdam
3. Circular Prague by Circle Economy 3 (Hlubuček *et al*., 2019):
4. https://www.circle-economy.com/news/how-prague-can-boost-innovation-through-circularity
5. Cities in the Circular Economy by Ellen MacArthur Foundation (Ellen McArthur Foundation, 2017):
6. https://www.ellenmacarthurfoundation.org/assets/downloads/publications/Cities-in-the-CE_An-Initial-Exploration.pdf
7. The 15 Circular Steps for Cities by the European Investment Bank 5 (Byström, 2018):
8. https://www.eib.org/en/publications/circular-economy-15-steps-for-cities.htm

The Circular Peterborough Commitment has been co-created with a number of different stakeholders within the city to illustrate the complexity and interrelationships of urban systems. The top section of Figure 1.2.3 illustrates the linear relationship of urban systems that do not fully utilize assets. The bottom section shows how systems can transition for greater interrelationships in a circular city to share and maximize resource use as effectively as possible (Opportunity Peterborough, 2018, p. 7).

Figure 1.2.3. *The interrelated complexities within a typical city* , © *Opportunity Peterborough, 2018.*

Green Infrastructure (GI)

Green infrastructure (GI) means natural and human-made elements that provide ecological and hydrological functions and processes (Benedict and McMahon, 2006). Green infrastructure can include components such as natural heritage features and systems, parklands, stormwater management systems, street trees, urban forests, natural channels, permeable surfaces, and green roofs with the impact on human health and wellbeing benefitting communities.

1.10 Conclusions

Successful human-built environmental relationships are dependent on continuous development over the long-term, so that the results may be accurately assessed in accordance with the vision. This goal will depend on each step taken by the city leadership/stakeholders, each of which must be reviewed upon completion, analysing the data, the outcomes, and both the positive and the negative impacts on human beings.

A professional committee of experts together with grassroots organizations, stakeholders, different sectors from the academy, industry, health, construction, education, science and others have to accompanying the whole process of decision aiming to achieve the updated vision of relationships between human and his/her age group with the built environment.

2 Smarter Together Case Study – Scaling-up district level eco-refurbishments with on-site renewable energy generation across Europe

By Naomi MORISHITA-STEFFEN and Baptiste MOUGEOT

2.1 Introduction

The EU has set a carbon-neutral target for 2050 as a response to the climate emergency. By ratifying the European Green Deal, EU Member States agreed to take measures against climate change (European Commission, 2019). Increasingly, national carbon neutrality objectives set by each member state are exceeded by municipalities through joint programs and subsidized actions at European, federal, and local levels. City-wide initiatives addressing global warming are multiplying. At present, 116 European cities are benefiting from EU grants developing sustainable city solutions (SCIS, 2020).

2.2 Background

Teams from eight international cities came together to form a consortium from 2016 to 2021 to build a bridge from state-of-the-art research innovations to actual implementations in the Horizon 2020 Project, Smarter Together. The smart city project is structured around the LightHouse City (LHC). There are three LHCs, Lyon, Munich, and Vienna; three follower cities, Santiago de Compostela, Sofia, and Venice. Each LHC, Lyon, Munich, and Vienna, is developing sustainable smart city demonstration districts, and actively developing urban innovations. Each LHC participates as a real laboratory for urban innovations promoting regional resilience and responding to local ecological, economic, and social challenges. The purpose of the smart city project is to serve as a paradigm for developing smart city solutions for other municipalities with similar goals. The innovation project focuses on five main themes: data management and intelligent digital services, renewable energy sources, holistic building renewal, e-mobility, and citizen engagement. Many topics are explored through the lighthouse cities of the Smarter Together project. However, the central subjects to the project are eco-renovation increasing building energy efficiency incorporating district-level renewable energy generation and uses. The success of implementing district-level deep energy building retrofits with micro renewable energy generation and distribution is dependent upon the cooperation level between stakeholder groups with different interests. A management structure combines citizen and stakeholder needs for district eco-renovation and renewable energy systems within each city. Strategies are shown below that respond to the local situations in three different countries, France, Austria, and Germany, to increase the district-level refurbishment rate, urban densification, and renewable energy use. Austria has far lower total carbon dioxide emissions (72.36 Mt) than France (314.74 Mt) or Germany (702.60 Mt) due to differences in population size (World Bank, 2020). At the beginning of 2020, Austria had a population of 8.9 million people (Statistik Austria, 2020). In comparison, at the beginning of 2020 Germany and France were the most populated European countries with populations of 83.2 million (Statistisches Bundesamt, 2020) and 67.1 million (INSEE, 2020), respectively. France's high dependence upon nuclear energy for electricity production is reflected in its extremely low carbon impact (RTE, 2020).

2.3 The Lighthouse Districts

Each LHC decided to renew an urban municipal district that has declined over time. The following paragraphs outline the key features of each quarter.

Lyon's Confluence demonstration area lies at the southern end of the city centre, on a peninsula where the Saône and Rhone Rivers merge. Smarter Together in Lyon builds upon an existing urban redevelopment project in the District of La Confluence that began in 1999. La Confluence renewal area is one of the largest in France. Historically, La Confluence had a mixture of heavy industry, commerce, working-class housing, and a prison. It was a landmark for illegal activities such as drug trafficking and prostitution. After deindustrialization, factories at the urban peripheries, and the district became a sizeable industrial wasteland. The idea to redevelop La Confluence came from the solid political will to enlarge the city centre of Lyon and to create a new resilient and smart district. The project area measures 1.5 km^2 with a floor area of 600,000 m^2, and 1,000,000 m^2 of new buildings. The project is the first WWF-approved (World Wildlife Fund) urban development in France with a net-zero greenhouse gas emissions target. The population of 12,000 people is diverse in age, income, and socio-economic categories. 16,000 people work in La Confluence. The project area contains a mixture of residential, commercial, and government offices. La Confluence redevelopment plan is diverse including the transformation of heavy industrial lands, deep thermal renovations of the existing building stock ranging from historically preserved structures to newly built homes, and a portfolio of buildings with diverse uses.

Munich's revitalization district, Neuaubing-Westkreuz, lies on the western edge of the city and is the newest project district. Much of the residential building stock in the quarter was built over two decades, during the 1960s and 1970s. It is Germany's largest redevelopment area and is part of Munich's "Social City" Urban Development Program. Neuaubing-Westkreuz is not only Munich's largest city district, but it is also geographically the largest of the three LHC districts with a total area 34 km^2. It is also the least densely populated area in Munich with 23,000 inhabitants and a population density of 1,200 people per km^2 (Landeshauptstadt München, 2020). Like the other LHC districts, the population is a mixture of diverse cultural and socio-economic backgrounds. The populace is composed of German middle-class senior citizens who settled in the Neuaubing-Westkreuz in the 1960s and 1970s, and younger immigrants with different ethnic backgrounds, German as a second language, and modest incomes.

The eleventh District of Vienna, Simmering, is a historically industrial and working-class district. The Geiselberg – Enkplatz – Braunhuberviertel neighbourhoods together form the Smarter Together dedicated project area. In comparison with the other LHCs, Simmering is the smallest district with a total area of 1.5 km^2. Yet the neighbourhood has a high population density with a total of over 21,000 inhabitants and a population density of 14,000 inhabitants per km^2. The population density is much higher than the average for Vienna and is also the highest among all the LHCs. Moreover, it is a culturally diverse population. The average wage in the project district is lower than the Viennese average. The neighbourhood has a typical urban building stock for Vienna and has high replication potential. The building stock in the project area has a mixture of buildings constructed during the "Gründerzeit" from 1870 to 1914, buildings built between World War 1 and World War 2, and post-World War 2. The project district has an extensive stock of social housing.

District-Level Building Refurbishment and Renewable Energy Goals

Each LHC set different deep energy retrofit goals for their building stock. Local factors such as building typologies, construction traditions, ownership structures, building ages, local regulations, and building use varied not only between the LHCs, but also between the individual buildings in each portfolio. All

LHCs implemented on-site electricity generation using rooftop-mounted photovoltaic arrays, and connections to district heating networks to renewable-based combined heat and power plants (CHP). The renewable energy sources for the districts ranged from biomass and solar thermal, to geothermal. Table 1.2.1 summarizes the project goals for each city district.

Table 1.2.1. *Eco-refurbishment and renewable energy integration goals for each district.*

Districts	Eco-refurbishment Goals	Renewable Energy Goals
La Confluence, Lyon	> 35,000 m² deep-energy retrofits of existing buildings > Helping groups of building owners and social housing associations to implement energy renovation measures	> 1 MWp local photovoltaic-based electricity generation > District heating system: a decentralized biomass combined with heat and power co-generation
Neuaubing-Westkreuz, Munich	> Over 42,000 m² deep-energy retrofits of existing buildings > Helping groups of owners and social housing associations to implement energy renovation measures.	> 109 kWp photovoltaic production on roofs > Battery storage > Geothermal district heating connections
Simmering, Vienna	> 65,030 m² of existing buildings: three residential neighbourhoods with one social housing complex, and two city-owned buildings. > Construction of four zero-energy gymnasia with five integrated renewable energy systems.	> Solar thermal and photovoltaic production on roofs > Geothermal energy > photovoltaic / solar benches

Stakeholder Involvement

Each LHC has set up a dedicated team within a municipal corporation to coordinate between local authorities at all government levels from the municipal, regional, national, and EU levels and with individual citizen groups. Each team assists the different building owner types navigate through the entire eco-refurbishment process from advising over refurbishment and renewable energy innovations, supporting the subsidy application process, mediating and moderating between different stakeholder groups (especially where consensus between many owners must be reached, e.g., condominium owner associations), supporting the implementation process with legal advice, the tendering process, and the construction process. The teams accompany each building until the implementation is complete in all LHC districts.
Citizen and stakeholder engagement through co-creation activities are crucial to the project; therefore, there is a dedicated work package for citizen and stakeholder activities. SPL Lyon Confluence is a municipal corporation which collaborates with HESPUL, a non-profit association, to enable citizen engagement at multiple levels. Munich's MGS Münchner Gesellschaft für Stadterneuerung (Munich Corporation for City

Renewal) oversees and coordinates citizen engagement activities within Munich. Vienna has taken a more direct approach through its Department for Technical Urban Renewal that manages citizen and stakeholder activities.

The teams also aid projects increasing citizen engagement in all LHC quarters. The local citizens are crucial stakeholders in the project. Each team facilitates sensitizing, informing, and involving the local population to participate in community planning where they live in each district. Lyon created two urban living labs: Maison de la Confluence and the Eureka Club for La Confluence inhabitants. Munich has two urban living labs called Stadtlabore, meaning "city labs." Citizens can walk into the living labs to engage directly with the facilitators.

Vienna used a mobile living lab, SIMmobile, taking the lab to different locations around Simmering to inform local citizens of different events, encouraging their engagement. Figure 1.2.4 shows an overview of the activities in each living lab. Local citizens contributed great ideas for developing even more innovative projects at all locations.

Maison de la Confluence - Lyon	Stadtteillabor - Munich	SIMmobile -Vienna
Stationary approach.	Stationary approach.	Scouting approach, mobile information bus, developed with the Urban Renewal office.
Exhibition hall urban living lab.	Urban living lab with highly modular interior design in order to host many kinds of activities.	Travels to information and engagement events in VHS Wien, schools, Siemens factory site, and public events such as street festivals.
Open 2-3 days a week.	Open 2-3 days a week.	It changes location every 5-6 weeks.
Addresses all topics related to the urban project in the Lyon Confluence area with up to 8,000 visitors per year (mainly professional)	Open centre for social and cultural activities, event location, exhibition hall, a meeting point and a citizen centre.	Special features: two cargo bikes "Grätzlrad", "beat the street" Beat Box, and different add-ons (e.g., solar panel on the roof, a bike generator, and an energy quiz).

Figure 1.2.4. *The living labs in Lyon (left), Munich (centre) and Vienna (right), (Camilla Wikström © SPL Lyon Confluence / Laurence Danière (left), © MGS/ F. Wolf (centre), © PID/ Jobst (right)).*

2.4 Conclusions

The refurbishment rate exceeded 2% in all LHCs as early as 2019. The renovation rate will likely reach over 3% by the end of January 2021, when the project is complete. The results are incredibly positive in all cities, achieving over 140,000 m^2 of holistic deep thermal renovations, 20,000 MW of thermal installations, 88,000 m^2 newly connected to district heating networks, and 1,600 kW of photovoltaic power capacity installation. In addition, Munich and Lyon installed a battery storage facility. To date, over 35,000 citizens took part in activities and events at the Urban Living Labs in all three LHCs. Over 1,100 people participated in co-creation processes. As the project is still ongoing at the time of writing, the numbers will continue to increase.

The experiences gained during Smarter Together enable further expansion of efficient district-level refurbishments and renewable energy installations in the LHCs and follower cities. The Smarter Together project structure facilitates the sharing of ideas and experiences freely amongst the municipal project partners, so that the entire consortium can learn from the experiences of the LHCs for quick and efficient implementation of innovative solutions.

The implementations scaled-up from single buildings to groups of buildings at a district level connected to scaled-down local renewable energy production in each location. District-level renewal occurs simultaneously in the three LHCs meaning that the renewal measures are also scaled-up to a European level. Within each LHC municipality, future projects are in the planning stage building on the experience and structural knowledge gained from this project. The new projects are to be implemented city-wide. Establishing project-dedicated co-ownership trustees to coordinate the interests of key stakeholders with local site-specific conditions are the key elements to their success. These project activities connect district-level refurbishments with renewable energy production and use, and the involvement of local citizens.

2.5 Acknowledgements

Smarter Together has received funding from the European Union's Horizon 2020 Research and Innovation Programme under Grant Agreement No 691876. The authors therefore wish to thank the European Commission for the funding received to deploy smart city solutions in Lyon, Munich, and Vienna within the Horizon 2020 Smart Cities and Communities initiative.

3 Health and the Built Environment

By Zvi WEINSTEIN, Mădălina SBARCEA, and George ONOFREI

3.1 Introduction

Massive urbanization, resulting from accelerated industrial development and population growth, contributed to the development of buildings that have little to do with the environment or their occupants. Building used to focus on fulfilling certain criteria, such as aesthetics, function, adequate comfort, and financial aspects, but whether the buildings fit in with the natural and the built environment has yet to be sufficiently well considered (Harris *et al*., 2019).

It is increasingly acknowledged that place and space have an impact on human health and well-being and that individual actions aimed at enhancing lifestyle or health status are likely to be influenced by the environmental and socioeconomic context (MOEP, 2017). The built environment represents the physical structures in which people work, relax, socialize, and access services of all sorts. It also includes several health determinants such as housing, neighbourhood and transport routes, all of which shape the social, economic, and environmental conditions that influence good health (Bartuska, 2007).

Two of the main questions on the topic of health and the built environment are: Could we use restorative and regenerative approaches to both improve the quality of life and cope with the complexities of the built environment? To what extent does “doing better rather than less bad” (Brown and Haselsteiner, 2018) fit the policies aimed at achieving better human health conditions within the built environment?

3.2 Factors of influence

There are several factors that impact the relationship between human health and the built environment. We present some of them below, from general-to-specific, as follows:

> Global ecological network; climate change; biodiversity;
> Natural environment; air, water, and earth; natural habitats;
> Built environment; buildings and places; streets, tracks;
> Microeconomics, politics, mega powers;
> Activities; work, shopping, movement; living, playing, learning;
> Local economy; capital creation; markets;
> Society; social capital; networks;
> Lifestyle; nutrition, physical exercise; work-leisure balance;
> Demographics, age; gender; genetics.

The built environment impacts health and well-being directly and indirectly. The direct impacts are most frequently related to air quality, noise, climate, and water quality and quantity.

The indirect impacts relate to the way the features and design of the built environment may influence the individuals’ and populations’ state of mind and behaviour. These impacts are considered largely interdependent and have been associated with both physical and mental health (Frumkin *et al*., 2004; Croucher *et al*., 2007; Swanwick *et al*., 2003; Dempsey, 2008; NICE, 2008; Devarajan *et al*., 2019).

Air pollution

The World Health Organization ([WHO] 2004) indicated five main substances that have harmful effects on indoor air quality: radon, tobacco smoke, cooking pollutants, volatile organic compounds, and asbestos, all of which have been linked to respiratory diseases.
Outdoor air quality is mainly affected by traffic and industrial CO_2 emissions. The WHO has linked transport air pollution to numerous health issues, including asthma, rhinitis, cancer, and adverse pregnancy and birth outcomes.

Climate

Climate change has become the most serious problem of our day and age, with extreme weather events influencing extensive parts of the globe, resulting in poor crop yields, population displacement and potential conflicts between countries, which could significantly impact the existing trade structure upon which cities rely (McMichael, *et al*., 2008; Salehyan, 2008).

Water

The coupling of climate change and population growth may increase the proportion of the population at risk from flooding. Continued urban development that uses impervious materials, which support surface water runoff, especially on floodplains, increases this risk.
Flooding is also likely to result in the prevalence of mental health symptoms in flooding victims, including depression, post-traumatic stress disorder, and anxiety (Mason S. *et al*., 2010). Vulnerable groups are more likely to be affected and may have fewer resources to deal with the aftermath (WHO, 2009).

Noise

Noise-related problems are more prevalent in socio-economically disadvantaged areas where highways intercross urban and peripheral areas, industrial zones, and higher-density residential areas. Despite providing opportunities for neighbours to interact, conflict risk is also higher and can result in social withdrawal (Bramley *et al*., 2009).

Housing and Neighbourhoods

On average, people spend 90% of their time indoors, and mostly at home (Deguen *et al*., 2010). Several housing factors, such as air quality, dampness, infestation, noise, lighting, housing tenure, and design are associated with mental and physical health issues.
People require well-designed homes in order to maintain good health. Their homes must be insulated, dry, warm, have natural air circulation, be spacious, and be located near friendly neighbours in places with a variety of services to supply their needs.
Disadvantaged neighbourhoods feature social and environmental problems affecting the inhabitants: vandalism, graffiti, property damage, drug use, noisy neighbours, abandoned spaces, and littering (GCPH,

2013). Such neighbourhoods may also present derelict land, poor-quality green spaces, a lack of street-lights, poorly maintained pavements, and community-served buildings.
A wide range of measures can be taken to enhance people's perceptions of safety, encourage walking and cycling, as well as improve mental health. The physical characteristics of neighbourhoods that have a positive impact on health, well-being, and physical activity are choice and diversity, well-kept environments, affordable and efficient public transport, safe areas, and green spaces.

Social environment

Social fragmentation and the loss of social cohesion have been identified as factors that damage mental and physical health (Echeverria *et al*., 2008; Ross and Mirowsky, 2009). There is also evidence that urban sprawl increases the social stratification of communities, which can negatively affect trust and social capital (Mason, 2010). The distance between work, home, and amenities can be detrimental to health and well-being due to the time spent commuting.

Connectivity, density and land use mix

Sustainable travel choices are given by the quality of the built environment and the connection between places. Walkable neighbourhoods are generally characterized by high population density, pedestrian amenities, different types of land use, high connectivity between different destinations in the neighbourhood, good accessibility to facilities, green spaces, and transport links (Maas J. *et al*., 2006). Mixed land usage increases liveability and its attractiveness to citizens and outside visitors, positively impacting upon the local economy, urban development and, in consequence, upon the well-being of inhabitants.

The role of nature

To improve the relationship between the built environment and people's health, taking into account all of the sectors mentioned above, the role of nature and its value for human health, particularly in urbanized societies, has been increasingly studied over the past decade, providing quite strong evidence for restorative effects (Hartig *et al*., 2014).
In their literature review on the relationship between public health and the built environment, Kent and Thompson (2014) proposed three domains where urban planning can most effectively focus on support for health and well-being:
1. The built environment and physical activity;
2. The built environment and connecting and strengthening communities; and
3. The built environment and equitable access to healthy food.

Nature-based solutions contribute in all of these areas by encouraging citizens to lead a healthier lifestyle by increasing attractiveness of urban infrastructure that supports active transportation: walking paths, cycling lanes; supporting community interaction in safe and attractive public spaces; and by providing productive urban landscapes (Viljoen *et al*., 2005) with sustainable food systems (urban agriculture and gardening), as well as other beneficial effects such as pollution absorption, cooling from tree foliage and increased biodiversity.

Using nature in the built environment in support of citizen's health and wellbeing is based on a few concepts that are increasingly present in sustainability frameworks.

Biophilic Design

Many researchers link the restorative effect of nature with the biophilia concept. Wilson (1984) defined biophilia as the innate urge of humans to affiliate with nature and other forms of life and life-like processes. Biophilia, "the innately emotional affiliation of human beings to other living organisms" is considered an integral part of both the human development process and physical and mental growth (Kellert and Wilson, 1993). Building on this concept, biophilic design (Kellert *et al.*,2008) promotes specific principles and patterns of nature-based parameters for the built environment that support health and well-being, by either mitigating common stressors or by enhancing certain qualities such creativity, memory, focus, relaxation etc. (Ryan *et al.*,2014). Biophilic design often complements the salutogenic design approach, by using the connection with nature to pro-actively support health rather than only interfering to treat illnesses (Mazuch, 2017).

3.3 Ecosystem Services & Nature-Based Solutions

The review conducted by van den Bosch and Ode Sang (2017) established that a positive relation between health and nature can result in direct health outcomes, mostly based on the delivery of EcoSystem Services (ESS) – cultural and regulating services.
According to the definition of the Millennium Ecosystem Assessment (2005), regulating services includes the benefits associated with the regulation of ecosystem processes (air quality maintenance, climate regulation, water regulation, erosion control, water purification, waste treatment, regulation of human diseases, biological control, pollination, storm protection), while cultural services are the non-material benefits that support human values and behaviour (cultural diversity, spiritual and religious values, social values, sense of place, cultural heritage values, recreation, ecotourism).
Human health in the ecosystem services approach can be regulated through ecosystems, especially when considering that healthy and functional ecosystems can determine health outcomes. Cultural ESS acts more indirectly on health, involving socio-behavioural aspects and producing benefits such as stress reduction and increasing physical activities. Regulating ESS acts directly on environmental and physical effects, mitigating health risks and adverse impacts, such as the reduction of heat waves and pollution. ESS pathways could also be related to economic co-benefits, such as the reduction of health-care costs.
A review and summary of epidemiological evidence, based on ESS-related pathways, was proposed by Braubach *et al*. (2017). Including also social equity issues and focusing more on cultural services provision, they explored improved relaxation and restoration, improved functioning of the immune system, enhanced physical activity, improved social capital associated with NBS implementation. These services provided by urban green spaces translated into direct effects for health. Their evidence suggests that they provide support for improved mental health and cognitive functions, reduced cardiovascular diseases, reduced prevalence of obesity and type 2 diabetes, improved pregnancy outcomes, increased lifespan. Additionally, there are studies supporting the role of nature in improving recovery periods after medical treatment and quicker healing in green hospitals (Huisman *et al*., 2012; Ulrich, 1984, Guenther, 2017).

3.4 Future challenges

While the relationship between health and the built environment is now an established research focus, its complexity and context-dependency require further conceptualization, through frameworks that support built environment professionals in their practice towards healthy urban settings.

Complex problems can often be resolved through nature-based-solutions that provide a series of benefits, most of which can be assessed from an ecosystem services perspective. The planning and implementation processes usually involve multiple stakeholders, from governments to NGOs and lay citizens. Besides further need for monitoring, especially of quantitative effects, the complexity of interactions between humans and their urban environment requires a system approach to adequately represent feedback loops between public health and features of the built environment.

4 Review of Sustainability Assessment Tools for Buildings and Cities

By Gulben CALIS, Dorota KAMROWSKA-ZALUSKA, Ezgi KOCAMAN and Merve KURU

4.1 Introduction

The recent COVID-19 pandemic has compelled people to stay at home more than usual and has even changed the working style of many traditional sectors permanently, shifting from office to remote work-at-home. Providing the requirements for personal comfort, including warmth, air quality, light, and acoustics within buildings therefore assumes an ever more important dimension. Sustainability in buildings therefore becomes mandatory and more urgent than ever, as it directly affects the health and the well-being of occupants. Furthermore, improving Human Building Interaction (HBI) also follows the broader definition of the sustainable built environment. Research into HBI aims to study human interactions within buildings, and to develop interactive technologies for the evaluation and the improvement of human-building collaboration, moving towards energy efficiency, comfort and collaboration (Lalanne *et al.*, 2016). HBI places increased emphasis on human interaction and highlights the collaboration of biological, social, and physical sciences, and engineering disciplines (Godfrey, 2010; Shan *et al.*, 2018). HBI is a two-way dynamic mechanism, comprising both the impacts of the built environment on occupants, and occupant feedback to the built environment. Similarly, cities also have a huge impact on human comfort, health, and well-being, so the negative impacts of cities on these aspects need to be minimized. While many cities have so far focused primarily on energy efficiency, the next step towards sustainable cities requires a significant increase in the use of renewable energy (RE) as well as HBI. Certification programs and rating systems are widely used to assess the performance of buildings and cities. However, current rating systems focus on selected aspects, such as energy efficiency and quality of materials and workmanship while some of them evaluate environmental impacts and reflect priorities among parameters. Yet the importance of HBI is often neglected and omitted in these systems. Therefore, the specific issues related to the HBI need to be identified in the rating systems so that a guide can be developed for designers, practitioners, and policy makers to support the process of generating comfortable, healthy, and environmentally friendly environments.

4.2 Building Assessment Tools

Building certification systems comprehensively integrate different segments of sustainability into their evaluation, in which the result is expressed as a whole number or a percentage of earned credit points. In general, key characteristics of the systems can be categorized as follows:

1. Environmental dimension of sustainability: In this category, the environmental quality of buildings and the negative environmental effects of buildings are investigated. Typically, once used, resources can be categorized as: (1) energy, (2) materials, (3) water, and (4) land.
2. Economic dimensions of sustainability: The economic aspects are related to cost monitoring, economic efficiency calculations, and the life cycle cost analysis.
3. Regulations: Building certification systems include predefined norms that are usually based on national and supra-national building regulations and codes that differ in scope and strictness. This over-abun-

dance of standardization causes inconsistencies in baseline assumptions and comparable thresholds of building quality (Reed, Wilkinson, Bilos, & Schulte, 2011)

4. Social dimensions of sustainability: Although building certification systems have to include social aspects, they cannot incorporate them in their assessments since social sustainability remains an ambiguous concept (Klotz and Grant 2009). Social sustainability is fundamentally related to people; in the building sector, this concept is a process for improving community access and engagement as well as social safety, health, and well-being during a project's life cycle, considering both current and future needs (McArthur and Powell, 2020; Herd-Smith and Fewings, 2008; Dillard et al., 2009).

While building certification systems have established processes to address environmental and economic aspects as well as regulations, they specifically fail to recognize social aspects. Building certification systems have to take into consideration human building interaction (HBI) data, in order to address these aspects, which is beneficial to understand and to shape people's experiences both with and within their built environments. In particular, HBI can be classified as (1) spatiotemporal patterns of occupancy, (2) occupant perceptions and preferences for the indoor ambient conditions (e.g., thermal, visual, and acoustic comfort), (3) occupant awareness of the energy and environmental implications of operations (i.e., studies on eco-feedback in indoor environments), (4) occupant interaction with appliances and control interfaces, and (5) occupant activity level (Jung and Jazizadeh, 2019; Heydarian *et al.*, 2020).

Building certification systems started with the launch in 1990 of the Building Research Establishment's Environmental Assessment Method (BREEAM), the first green building rating system in the world. This green building rating system is measured across 9 categories: management, health and well-being, transport, water, materials, land use and ecology, and pollution. Next, the U.S. Green Building Council (USGBC) developed criteria, which is aimed at improving the environmental performance of buildings through its Leadership in Energy and Environmental Design (LEED) rating system in 2000. LEED has nine focus areas, including location and transportation, sustainable sites, water efficiency, energy and atmosphere, material and resources, indoor environmental quality, innovation, regional priority, and integrative processes. Starting in 2005, the Comprehensive Assessment System for Building Environmental Efficiency (CASBEE) was developed in Japan as an approach for environmental impact assessment of buildings. CASBEE assesses the energy and resource efficiency of a building as well as local and indoor environments. DGNB is a green building certification program developed by the German Sustainable Building Council. This system evaluates the buildings based on ecological quality, socio-cultural and function quality, technical quality and process quality. In 2010, the Sweden Green Building Council developed Miljöbyggnad, a green building certification program that focuses on indoor environmental quality, energy use, and material use. Miljöbyggnad uses the principles from LEED and BREEAM to develop its certification attributes.

Other countries also followed the growing interest for sustainable design including the Hong Kong Business Environment Council that developed BEAM PLUS. This certification programme focuses on assessing site, material, water and energy use, indoor environmental quality, and innovation. In Australia and South Africa, Green Star is used to assess sustainability in categories such as indoor environmental air quality, energy, transportation, water, materials, land use and ecology, and emissions. In Canada, first, the R-2000 Home Program was developed as a performance-based system, specifying an energy consumption target for a house and a series of technical requirements. Furthermore, Novoclimat is developed by the Quebec Agency for Energy Efficiency based on Canada's National Model Energy Code and R-2000 program. The main goals of the program are to decrease energy consumption, improve occupants' comfort, and ensure good indoor air quality. In addition, Green Globes is a building rating system used in the US and Canada. This certification program focuses on energy usage, water, waste management, emissions, indoor environ-

ment, and environmental management. However, the human dimension is not sufficiently well addressed in these certification systems, in so far as comfort, health and well-being are not promoted.
Recently, health and wellness factors in the built environment started to be recognized in certification programs, which resulted in the development of Healthy Building Certification systems including WELL and FitWel. WELL is a building certification program managed by the International WELL Building Institute (IWBI). WELL assesses the buildings based on 11 categories including air, water, nourishment, light, movement, thermal comfort, sound, materials, mind, community, and innovation. WELL focuses mostly on occupant health and well-being whereas the focus of Fitwel is not only on building-occupant health and wellbeing, but also on the surrounding community. Accordingly, FitWel utilizes building attributes including location, building access, outdoor spaces, entrances, stairs, indoor environment, workspaces, shared spaces, water supply, cafeterias and prepared food areas, vending machines and snack bars, and emergency procedures. The Living Building Challenge is a trademark of the International Living Future Institute (the Institute). It includes seven assessment categories: place, water, energy, health and happiness, materials, equity and beauty. Therefore, it can be presumed that these systems establish the basis for integrating the human dimension in the certification programs.

4.3 Urban Scale Assessment Tools

Measuring the performance of sustainable cities has, in recent years, received intense attention. Local Agendas 21 (UN-Habitat, 2002) introduced at the Earth Summit 1992, was one of the first holistic instruments for measurement of the actual state and future directions of urban development. Later, other standards and Key Performance Indicators were introduced to measure sustainability at a global level. The most important are the UN 2015 Sustainable Development Goals (United Nations, 2015). They were further operationalized at a local scale, but their usability for assessing single projects is limited. Human built environment interaction is one of the major aspects of the UN Sustainable Development Goals, namely: SDG 11 connected directly with smart cities and communities and SDG 3 good health and wellbeing, as well as SDG 6 clean water and sanitation as the form and shape of the built environment determine the living conditions of urban dwellers.
At the same time, there are more than one hundred existing KPI (Key Performance Indicator) systems that may be used to assess city sustainability. Most assess both the quality of life of the urban population and the built environment, however only a few integrate a holistic assessment of human-built environment relations.

Some of the relevant European Union funded projects and the documents communicated from the EU agencies are as follows:

1. URBES Project, https://www.iucn.org/regions/europe/projects/cities-and-regions/urbes-project
2. Transform 6th Framework Project, http://www.transform-eu.org/
3. City keys H2020 project, http://www.citykeys-project.eu
4. SSCC-CG Final report - Smart and Sustainable Cities and Communities Coordination Group
5. Sustainable Cities International (SCI) Indicators for Sustainable Cities, European Commission, Europa EU - http://ec.europa.eu/.../indicators_for_sustainable_cities_IR12_en.pdf
6. Closing the loop - An EU action plan for the Circular Economy - Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions, COM/2015/0614 final
7. Applied framework for evaluation in CIVITAS PLUS II.

8. ClimateCon Urban Metabolism Framework, European Environmental Agency, http://ideas.climatecon.tuberlin.de/documents/wpaper/CLIMATECON-2011-01.pdf
9. Global City Indicator Facility - is a program of the Global Cities Institute (GCI).

GCIF hosts a network of 255 cities across 82 countries committed to building standardized city indicators for performance management including a database of comparable statistics that allow cities to track their effectiveness on everything from planning and economic growth to transportation, safety, and education. With initial backing from the World Bank, this fully integrated University of Toronto project has resulted in the creation of ISO 37120 – the first international standard on indicators for sustainable cities. This assessment framework covers all aspects of sustainable city development from energy and transport to water systems. It also focuses on quality of life and environmental protection including biodiversity, but at the same time it does not cover more holistic indicators such as wellbeing. Moreover, only some aspects of topics such as circular energy and material flows are covered, namely solid waste and water treatment. A KPI refers to selected indicators that measure key aspects of performance. KPIs need to be identified to measure the effectiveness of sustainability actions at an urban scale. Among the best known KPIs are those defined by the ISO 37120 Sustainable Development of Communities: Indicators for City Services and Quality. ISO 37120 defines and establishes methodologies for a set of indicators to steer performance by measuring city services and quality of life. It was developed for a holistic and integrated approach towards sustainable development and resilience, but again the focus of this standard is more on traditionally understood sustainability approaches, and regenerative principles are not reached. Its main advantage is that it can be applied to any city, municipality or local government that undertakes to measure its performance in a comparable and verifiable manner, irrespective of size and location. However, this approach also has its constraints: the data used for KPI need to be easily accessible, thereby eliminating more complex indicators such those which measure processes or time spans of longer duration for life cycle measurement.

Key performance indicators from the ITU-T Focus Group on Smart Sustainable Cities proposed a set of KPIs that were specifically focused on a set of ICT-related indicators for smart sustainable cities. The group categorized KPIS in six dimensions, which are (1) Information and Communication Technology, (2) Environmental Sustainability, (3) Productivity, (4) Quality of Life, (5) Equity and Social Inclusion, and (6) Physical infrastructure. In addition, UNECE and the International Telecommunication Union (ITU) introduced Smart Sustainable Cities Indicators, which were developed within the "United Smart Cities" project. The group developed a tool to evaluate how smart and sustainable a city is and to serve as a starting point to implement concrete actions and measures and to improve the sustainability level of a city. The UNECE-ITU Smart Sustainable Cities Indicators help cities to evaluate their performance against the SDGs. This group of indicators connect sustainability with smartness and as such have strong focus on digitalization. At the same time, both KPI (Key Performance Indicator) frameworks are based on a human-centred definition of the smart city, which is consistent with the principle of the smart city as an urban organism responding to the needs of society.
Some influential frameworks used to assess the implementation of projects focusing on urban regeneration are, among others: The China Urban Sustainability Index (Urban China Initiative), the Indicators for Sustainability (Sustainable Cities International), the Reference Framework for Sustainable Cities (RFSC), and STAR Community Rating System Sustainability Tools for Assessing and Rating Communities. Important sets of indicators were introduced within initiatives such as: City Blueprint (Waternet Amsterdam; KWR Water; Cycle Research Institute), the European Green City Index (Economist Intelligence Unit; Siemens), and Urban Ecosystem Europe (International Council for Local Environmental Initiatives (ICLEI)). The latter focuses primarily on environmental issues, while social indicators that can be used to assess social sustainability in terms of positive physical, social, and psychological benefits, among others, are less developed.

If the level of comprehensiveness and universality of use is taken into consideration, another widely used framework to assess sustainability at the community level is the Egan Wheel (Office of Deputy Prime Minister, 2004). It offers an easy method for the analysis of various aspects of sustainability, by identifying the skills needed to deliver sustainable communities within eight sectors which are as follows (Office of Deputy Prime Minister, 2005):

1. active, inclusive, and safe - fair, tolerant and cohesive with a strong local culture and other shared community activities;
2. well run - with effective and inclusive participation, representation, and leadership;
3. well connected - with good transport services and communication linking people to jobs, schools, health, and other services;
4. well served - with public, private, community and voluntary services that are appropriate to people's needs and accessible to all;
5. environmentally sensitive - providing places for people to live that are in harmony with the environment;
6. equity - fair for everyone;
7. thriving - with a flourishing, diverse and innovative local economy;
8. well designed and built - featuring quality built and natural environment.

The Egan Wheel is a comprehensive tool for sustainability assessment, although we need an assessment framework that can be used to measure full life cycles, to assess flows of materials and energy as well as processes instead of states. By doing so, human settlements may be transformed into more regenerative communities (Kamrowska-Zaluska, Obracht-Prondzyńska, 2018) through a focus on a holistic approach and human-nature-build environment relations.

4.4 Conclusion

While sustainability rating systems for buildings and cities have been established for quite some time now, systems that include HBI data in their evaluation methodologies are not common. Although the basic goal of the assessment tools is to minimize negative environmental impacts and they are not therefore primarily developed to promote comfort, health, and well-being, they need to contemplate and incorporate aspects that can provide positive physical, social, and/or psychological benefits to building occupants. These aspects can be investigated through an understanding of the HBI, which provides insights into levels of visual, thermal, and acoustic comfort for occupants and their patterns of energy consumption.

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Esta es una Plaza Project. *(Source: http://estaesunaplaza.blogspot.com/p/dossier.html)*

1.3

Scale Jumping: Nature – Built Environment Interactions

Small Urban Hacks - Big Impact! Tackling major urban challenges through acupunctural smallness

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Summary

Small urban hacks, acupunctural action and process-oriented planning approaches might appear to address quite a socio-romantic attitude towards our urban environments. In this chapter, our aim is to remedy such a biased view, demonstrating the impact and potential of smallness in the context of major urban challenges. Small urban hacks and their multi-faceted and creativity-driven approaches of small is beautiful are selected from all over Europe to investigate the rigidity of the existing urban fabric. Small actions are reflected in a quantitative and qualitative way, analyzing and critically dissecting their impact, civic acceptance and efforts to achieve a resilient future urban spirit. This meticulous inspection reframes the urban acupuncture standpoint, outlining the possibility for reconciliation between both former and current planning credos in view of present and upcoming urban threats.

Addressing Scale Jumping

Scale jumping is the general composition of the urban fabric: from the urban furniture to the street, from the tree to the park, from the park to the highly dense neighbourhood, from the dense neighbourhood to the district, from the district to the piece of urban fabric. Such jumps have been taken over centuries, creating friction and discomfort between the different approaches towards the composition of cities and the process of their construction; the response to the already quite complete design of cities will not be to add another strict planning credo. Furthermore, future demands will be subordinate to what is already in existence. Starting with smallness, creating a larger impact could lead to a more consensus-oriented approach, diminishing unpleasant side effects.

Small Urban Hacks - Big Impact! Tackling major urban challenges through acupunctural smallness

By David CALAS, Edeltraud HASELSTEINER, Marielle FERREIRA SILVA, Aránzazu GALÁN GONZÁLEZ, Emanuela GIANCOLA, Mihaela HĂRMĂNESCU, Dorota KAMROWSKA-ZALUSKA and Silvia SOUTULLO CASTRO

1 Introduction

Environmental and natural relations are the cradle of our settled and built society. A rooted approach that out-synced itself from the natural environment due to increasing fossil-fuel dependency. Since the first turning point in the 70s, motivated by the oil crisis of 1973, sustainable approaches appear to have continuously accompanied the built environment though without impact. Current global climate concerns demand broader and more circular access to environmental relations within the built environment. A syncing process that leaves overused terminology such as “green” and “sustainable” facing obsolescence.
A remedy to a misleading building and planning approach within its natural environment will be outlined. A path that must be driven by an act of reconciliation between the built environment and its natural surroundings.

2 Premises

In recent times, large-scale urban planning has aimed to tackle wide-spread urban issues. An approach that will at least provide relief for urban expansions as well as large-scale (re)densifications by dealing with decade-long problems. Nevertheless, this method of planning to combat global climate effects is missing the existing urban fabric of our (European) cities (Mitscherlich 1965). Urban structures have over several centuries occupied most urban space, demonstrating a certain structural rigidity. Circumstances that direct the perspective of this research work to the existing urban textile and take a closer look at measures for sustainable development.
This research focuses on small interventions, the small common denominator used to place the big picture in relief. An approach that appears too small in the face of the task at hand, but which should be considered in a differentiated way in terms of scalability. Summarized as: Small Urban Hacks - Big Impact!
The research design deepens the small-scale nature of the project(s) by broadening the focus with regard to scalability, transferability and success factors. A holistic view that examines practical examples from different European cities, in order to locate the dynamics of acupunctural use in relation to governance and social acceptance.

3 Research Model

The discussion of the research is based on a dual approach (Figure 1.3.1). The specific approach (1) starts from the small hacks and considers their influence on the existing urban fabric as well as the use of nature.

The broader/holistic approach (2) takes up the effect(s) of the specific detail, in order to consider social acceptance and governance in a holistic reflection.

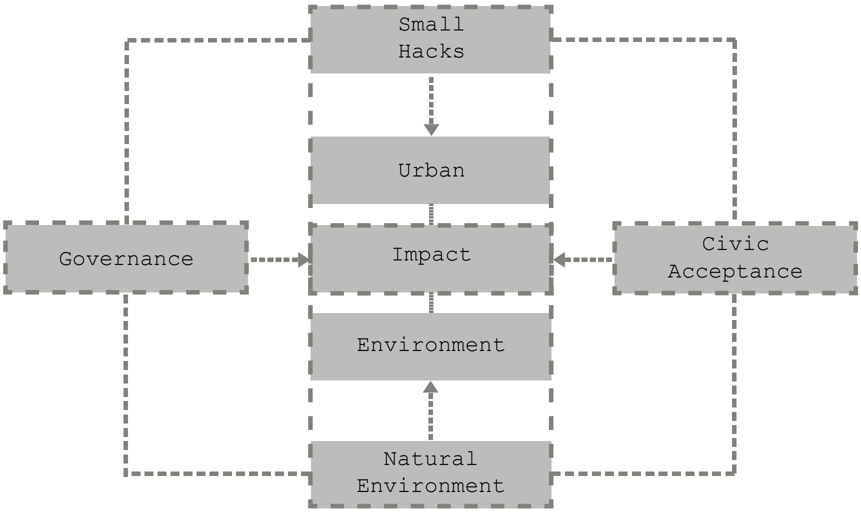

Figure 1.3.1. *Research Model. (Credit: © David Calas).*

From this model (Figure 1.3.1), which is evaluated by using a coordinated assessment frame, weaknesses and strengths will be identified. A research design will be used as a basis for setting the objectives and preparing the guidelines for action.

4 Position paper for future urban demand(s)

Research Question

How can small-scale urban hacks impact the existing urban fabric in relation to common climate-change related urban challenges from a holistic point of view?

Target

In this research work, the status quo of current measures to contain unpleasant urban climate issues is examined. These measures are mainly developed or planned by expert planners and therefore show a narrower perspective compared to the larger common denominator. An implementation strategy that could or in fact does lead to friction over certain deployments, which is why a fully holistic view is necessary. The intention behind this research work is not to limit itself to the observation and identification of synchronisation difficulties, but rather to enhance the overall view by enabling action. The aim of this work is to create holistic guidelines for dealing with urban climate issues as a top priority and circular necessity.

5 Approaches of Urban Acupuncture

The theory of Urban Acupuncture is related to the proposal of small interventions within the city, which can together transform the entire urban context, revitalize certain strategic points within the city and then can act as a core that gradually heals the entire urban metabolism (Lerner, 2014; Fredericks *et al*., 2019). The origins of the concept are related to the acupuncture method, namely the insertion of a thin needle at specific points over the body, in order to treat certain diseases and to reduce pain. In a similar way, urban acupuncture must be implemented in places that need healing. Those sites need to be chosen following an economic and social analysis of the whole context. Situated pop-up interventions have a potential to provide more inclusive forms of civic engagement (Fredericks *et al*., 2019) and to lead to urban change. Similar to the healing action of the human body, urban acupuncture is a strategy that seeks to improve the urban metabolism.

According to Lerner (2014), such interventions have the capacity to revitalize not only the place, but also the entire neighbourhood area. The interventions have the role of revitalizing the space, introducing changes into an urban organism and helping the community towards an essence of agency and co-ownership of the city. Thus, through urban acupuncture:

> urban health and life quality can be improved (urban kindness);
> urban gaps can be filled, temporary structures located in areas in need of revitalization can sustain a healthy mix of urban activities and the continuity of urban life, because continuity means life (continuity is life);
> old buildings can be recycled in order to maintain the iconic elements of the city (circular approach);
> green and blue infrastructure in the city can be improved, as planting trees will have a large impact on the urban environment (arborescence);
> city development can be influenced by including urban acupuncture interventions in city development plans and policies (systemic change).

While Lerner focuses on sustainability, Solà-Morales' (2008) understanding of urban acupuncture is related to urbanity and urban experience through the relation between human and urban structure in neglected places: urban periphery and waterfront.

Casagrande (2010) also advanced the human/nature relation through the theory of third-generation cities that consists of a three-stage cycle within which nature and man interact. In the first generation, people modestly use architecture to integrate it into nature, with the emphasis on the role of the environment and an understanding of nature. In the second generation, people exploit natural resources and develop industrial cities. Industrialism has given citizens independence from nature, but has led to depletion of natural resources and unbalance. Though, in the third generation of cities, nature will have taken control of architecture, architecture will be integrated into nature and the city will become an organic machine. It is not only the duty of architects, urban planners and designers to regain and save what is left of industrial cities. It is necessary to recognize genius loci, local knowledge and traditions. Casagrande is interested in this third-generation city where man returns to the ruins; the city has become an organic ruin of the industrial city. He considers the concept of urban acupuncture as one of the three concepts of the third-generation city besides 'anarchic garden' and 'river urbanism'. The *anarchic garden* represents the spontaneous and nomadic interventions that keep the organic machinery alive, such as community gardens and urban farms. *River urbanism* is a form of landscape urbanism in which the relation between the city and water is restored. During the second generation of cities, rivers were transformed into industrial sewers, and the new generation aims to bring cities together with these rivers through interventions that encourage the community to interact with water.

Casagrande claimed that the organic characteristics of the third-generation city are hidden beneath the industrial city. Calling this energy 'the underlying organic chi', he declared that it may be used to help transform the industrial city. Thus, urban acupuncture as a way to manipulate this chi should be related both to nature and to these energy flows of chi within the city. He considered it very important to let nature complete the work instead of man (Casagrande, 2015).

Urban acupuncture as a new planning approach broadens communication and strategically targets interventions across the city (Hoogduyn, 2014). It is also a current and effective urban revitalization technique, involving small investments, which will not necessarily require major interventions. This vital advantage adds flexibility to projects. If a proposal requires minimal funding, it can be implemented even in communities where development funds are limited. The small-scale approach to the problem is aimed at activating the weak spots within the city, which will then prompt change on a larger-scale. Urban acupuncture should be seen as an ongoing process. Interventions should not have rigid time frames, but should remain flexible, in order to adapt to the ever-changing needs of users. The bottom-up, pop-up interventions should rework their outcomes into an 'urban acupuncture framework' and serve as guide for the design of future interventions (de Waal & de Lange, 2019) that could support processes of participatory regenerative urban transformation.

6 Definitions of Hacks / Micro Interventions

The term Urban Hacking is the collective term for a series of activities or actions that are related to social, environmental and political protest. Urban-Hacking interventions seek to attract attention through small, targeted and as creative as possible actions. "…Urban Hacking contains a wide variety of interventionist strategies and (cultural) practices, theoretically binding them to each other and creating a toolbox for an alternative praxis, for a shared action field of political activism and aesthetic-artistic intervention. Its aim is to occupy the public space from within, much like the task of historical models such as the situationist movement, the Sponti-movement, the graffiti-movement and the guerrilla." (Apunkt-Schneider & Friesinger, 2014, p. 23)

We understand the term urban hacking from the perspective of climate change and the necessary adaptation strategies within cities. The aim of urban hacks is therefore primarily to improve the city climate and the rise in temperature through green and blue measures. Urban regeneration, social inclusion and a participatory approach are further key targets of these micro-interventions. In addition to the goal of implementing measures against urban heat islands, a new awareness of nature should be integrated into the city.

For the time being, urban hacks are small interventions that show niches, new opportunities and potential for using public space and existing urban infrastructure. In their idea of temporary actions, they are sometimes taken up and scaled up by organizations, companies and the city administration to a mainstream initiative on a larger scale. This path was followed, for example, in urban gardening projects. Originally created as small guerrilla actions, they are now a widespread element of every major city.

In our documentation of selected urban hacks, we differentiate between five categories:

Green: interventions with greening, rewildering and horticultural use of public spaces, e.g., urban gardening, urban agriculture;

Blue: like water with a cooling effect on the urban climate as a central issue;

White: combines measures in which deployment or improvement of air and air quality are the main subject;

Yellow: shifts the city's cultural values from a niche existence into a new light (governance implementation);
Circular: refers to interventions whose aim is to demonstrate the natural cycle of resources and materials within a city.

7 Evaluation method

Contemporary society is experiencing an economic change from an affluent, industrial society to a worldwide service-based society. Analyses of the spatial reality of urban society and urban space indicate that this change is accompanied and increased by spatial polarization within cities, which in the end affects the population's social opportunities, according to Häußermann & Kapphan cited in (Schöbel, 2006). These changed demands for political action stipulate thematic, social, and spatial settings for open space design. A change in perceptions and values in everyday life, however, also has an influence on possible policies. If these changes in living situations lead to differentiation and polarization, the change of social environments can strengthen such processes, and even has some potential to correct them (Schöbel, 2006).
Analysis based on qualitative and quantitative factors helps to evaluate the performance of urban strategies through key indicators. Quantitative factors refer to things that can be counted by number or by size and that can be compared between projects. Qualitative factors refer to more abstract non-numeric aspects, often specific to a single project, that affect its potential value.

Quantitative characteristics

a. **Time Frame**

The structures, circumstances, and events quickly appear and disappear, but they are designed to invest and embed themselves within society, public space, or a set of ideas (Sethjiwala, 2017).

i. Temporary: the architectural definition is where the structure lasts only for a limited period (Sethjiwala, 2017). It is present in a period of the year and is deconstructed after use.
ii. Repetitive: a structure that presents itself on more than one occasion and is assembled every year in the same period, or in different regions.
iii. Permanent: a structure that was set up once for a particular event or situation and has remained in place ever since.

b. **Scale**

The urban scale can be presented as three sizes: small, medium, and large.

i. Small: a one-off example, set in a street, block, or a neighbourhood.
ii. Medium: when the structure spreads out over more than one neighbourhood.
iii. Large: expanded and interconnected within a city.

c. **Approach**

In general, each approach can be top-down - from general to specific - and bottom-up - starts at a specific level and moves up to a general level.

i. Top-Down: an approach is based on higher values of authority as rules that set the higher goals for the smaller tasks.

ii. Bottom-Up: The bottom-up style presents a decision-making process coming from individuals or collaborative organizations, i.e., it gives the population a voice in the objectives of urban activities.

d. **Urban Acupuncture**

Urban acupuncture is a spark that initiates an action and its subsequent propagation. Planning is a process, which cannot generate immediate transformations hence the need for these interventions (Lerner, 2003).

i. Intervention: projects that intervene in a public space and disturb the built environment in order to inspire positive social results. Urban design interventions can be sanctioned or unsanctioned and often act as a laboratory for research and experimentation (Walter, 2013).
ii. Small Hacks: These are interventions through small, targeted, and as creative as possible actions, participatory in nature and of the people-power type.

e. **Replicability Level**

The level of project replicability refers to chances of a project inspiring others. Under replicability, we can discuss the intentional demonstrative potential of many of the projects, i.e., projects that illustrate the possibility of the progressive development model and the possibility of applying it at other locations, at different scales, or within different cultures. In addition, a model can be replicated in terms of its technology and methodologies.

i. High: when the model can be replicated in all the above-mentioned aspects.
ii. Medium: when the model can be replicated in some of the above-mentioned aspects.
iii. Low: when the model cannot be replicated or just in some particular cases.

f. **Impact Level**

This section is related to how urban hacks and their technologies and approaches can impact their geographical, social, and environmental space. Impact can be evaluated as low, medium, or high.

i. Geographical: As the project impacts in geographical terms, it is also related to scale, i.e., whether the impact is local, street, block, neighbourhood, or within a whole city region, the whole city, in multiple cities, or country wide.
ii. Environmental: Environmental Impact can be described by examining the expected environmental effects of a proposed project.
iii. Social: A social impact can be considered as the result of a set of activities as a significant and positive change that responds to a significant social challenge.

Table 1.3.1. Template for quantitative Indicators

Photo to be located here

Figure. *X Title. Source: XXX*

Category*	Time Frame			Scale		Approach		Urban Acupuncture		Replicability Level**	Impact Level		
	Temporary	Repetitive	Permanent	Small	Large	Top-Down	Bottom-Up	Intervention	Small Hack		Geographical**	Environmental**	Social**

** G = Green, B = Blue, Y = Yellow, C = Circular, W = White*
*** S = Small, M = Medium, H = High*

Qualitative characteristics

In addition to quantitative aspects, qualitative aspects can also be analysed. The effects of city characteristics will qualitatively vary the dimensions of each outcome. Qualitative analysis is used to assess values, in order to support urban hack decisions. The qualitative attributes scales are discrete and typically consist of utility functions and words rather than numbers. Usability is the main aspect, that describes the functions that public spaces need to fulfil for the public space network to be attractive to use (Mæland, 2019). Many approaches are contemplated beyond the qualitative analysis, such as new culture, innovation, action plan, playfulness, urban interactions, structure and diversity. Certain questions might be of help with this analysis, such as: Has everything been in the urban city before? How long will the hack survive? Are there any new innovations? How could it be replicable?
Qualitative science touches the thinking of landscape architecture, not only in terms of the creative subject with its specific understanding of social and cultural relationships, but in its methodological foundations as well. Its theory begins where it turns from the unique to the specific, without leaving the design process behind (Schöbel, 2006). Therefore, qualitative processes can help us to discover relevant criteria for the reappropriation of space within the city.

8 Selected Hacks/Interventions and their evaluation

Austria: Vienna

Vienna was for the 10th time (Mercer Study 2019) in a row selected as most liveable city in the world and the European 'capital' of social housing appears to have all the ingredients of a successful urban environment. Despite these awards, the city is in a continuous struggle for general liveability, affordable housing and successful measures to mitigate climate change. The latter are handled on a big scale with broad sustainable regulation for newly planned quarters/buildings, but also with small approaches, tending towards tactical urbanism and hacking strategies. A mixture that frames the package of measures but one that also outlines the need for scaling up to reach a reasonable climate shift.
The following five examples of hacks/interventions show the most popular current measures taken to combat urban overheating. Additionally, they also outline how a governmental agenda can use the framing of bottom up approaches to reach a balanced acceptance of the measure among citizens.

PARKLET / GRÄTZLOASE (Austrian term)

Info / Link: https://www.graetzloase.at/

Parklets are initiatives- and citizen driven projects which can be built up as temporary structures by occupying existing parking lots. The City of Vienna started with a pilot programme in 2016 providing incentives for parklet projects. Citizens are permitted to occupy parking spaces during summer months for hosting activities and as places to hang out. This process is strictly regulated through a system of permits and there is also the chance to apply for some funding for their implementation. The design of the parklet has to follow some regulations, but can include green or simply rolled turf and some urban furniture.
In response to criticism over permits and higher bureaucratic thresholds, the City of Vienna aims to offer digital "One-Stop-Shops" to facilitate a well-accepted implementation process by 2021.

Original hacking idea

The original action of this hacking idea among active citizens living in San Francisco was baptized with the name "Parklet Movement" in 2005. The aim was to express the right of citizens and to contribute to the environmental enhancement of the neighbourhood. The first parklet was more related to performance art by feeding the parking meter and installing greenery and temporary furniture on the occupied parking lot.

Qualitative Reflection

Parklets are based on abundant experiences. The acceptance and success of Parklets in the summer months acknowledge the shoulder-to-shoulder stance of hacking background and governance implementation. An easier regulative approach could enhance the creativity and transitory use throughout a whole year could be monitored. More permanent uses could widen the range of hacking car-driven street levels; measures that could tackle urban climate issues on a more intense scale.

Quantitative Indicators

Figure 1.3.2. *Parklet in Vienna, Kalvarienberggasse.* *(Credit: © streetlife).*

Category*	Time Frame: Temporary	Time Frame: Repetitive	Time Frame: Permanent	Scale: Small	Scale: Large	Approach: Top-Down	Approach: Bottom-Up	Urban Acupuncture: Intervention	Urban Acupuncture: Small Hack	Replicability Level**	Impact Level: Geographical**	Impact Level: Environmental**	Impact Level: Social**
G / C	X	X			X	X	x	x	X	H	M	L-M	H

** G = Green; B = Blue; Y = Yellow; C = Circular; W = White*
*** S = Small, M = Medium, H = High*

"SOMMERSPRITZER"

Info / Link: https://metropole.at/name-viennas-new-cooling-installations/

Sommerspritzer offers a small hack which can be plugged into available water hydrants. The hack aims to prevent heat-island effects in certain urban areas and on sidewalks by offering a solar powered mist shower. This "blue" hack was initiated 2019 by the City of Vienna to enhance the "cool" spaces city map. Originally kick-started with a participatory name assignment, the "Sommerspritzer" gained popularity in 2020

Original hacking idea

The hacking idea has its origins in the "misuse" of available hydrants. Citizens open up hydrants to cool streets or for playful reasons. The hackability of hydrants symbolizes a commonly used good (water) for urban cooling measures.

Quantitative Indicators

Figure 1.3.3. *Sommerspritzer at the Danube Island. (Credit: © David Calas).*

Category*	Time Frame			Scale		Approach		Urban Acupuncture		Replicability Level**	Impact Level		
	Temporary	Repetitive	Permanent	Small	Large	Top-Down	Bottom-Up	Intervention	Small Hack		Geographical**	Environmental**	Social**
B	X	X		X		X			X	H	L	L	L

** G = Green; B = Blue; Y = Yellow; C = Circular; W = White*
*** S = Small, M = Medium, H = High*

Qualitative Reflection

The use of "Sommerspritzer" offers not only a reflection on institutionalised hacking ideas, but also an outlook towards the creative use of existing urban furniture. Since the environmental impact is quite low, a broader hackability is required. A chance to enhance the existing approach applying a broader use towards greening. The latter also refers to possible broader civic acceptance, since significant criticism of the purpose and the aims of the current "Sommerspritzer" has been voiced.

“COOL STREET”

Info / Link: https://www.streetlife.wien/coolestrasse/

“Cool Streets” are temporary closed streets where folk can hang out, play and cool down in the neighbourhood. Initiated in 2019 the cool streets should provide a countermeasure regarding the increased tropical nights and heat island effects. In the so-called “outdoor living rooms” there are additional seating areas as well as opportunities to cool off with spray mist. Cars are not allowed to drive, stop or park in the “Cool Streets”. Residents from the neighbourhood are welcome to bring their own furniture and plants. This measure, has helped to reclaim streets from vehicular traffic and, together with support staff, has helped to raise awareness of urban climate issues.
In the summer of 2020 Vienna offered 18 temporary and, for the first time, 4 permanent reshaped cool streets. The meaningful location was determined in line with the Viennese heat map.

Original hacking idea

“Cool Streets” show a collection and concentration of hacks. Therefore, the origin refers to the civic engagement and acceptance of hackable spaces by city hall. The origin also has its roots in the “Spielstraße” [Play Street], established the 1960s, where a reduction of traffic should enhance the security of playing children. Cool Streets unify hacking and forward-looking governance-driven reclaiming of streets from vehicular traffic.

Qualitative Reflection

The impact and broad ranging acceptance of this measure underlines the significance of bounded hacking methods. In addition, the flexible management framework permits an appropriation of space and forward-looking governance tools targeting urban heat issues.

Quantitative Indicators

Figure 1.3.4. *'Coole Straße', Hasnerstraße. (Credit: © Christian-Fuerthner).*

Category*	Time Frame			Scale		Approach		Urban Acupuncture		Replicability Level**	Impact Level		
	Temporary	Repetitive	Permanent	Small	Large	Top-Down	Bottom-Up	Intervention	Small Hack		Geographical**	Environmental**	Social**
G / C	X	X	X		X	X	X		X	H	H	H	H

** G = Green; B = Blue; Y = Yellow; C = Circular; W = White*
*** S = Small, M = Medium, H = High*

(TACTICAL) URBAN GARDENING PROJECTS; GUERILLA GARDENS

Info / Link: i.e., http://gartenwolfganggasse.blogspot.com/

Urban Gardening projects are small interventions in the city to initiate (temporary) greenery and space for food production.

Original hacking idea

The original idea came from guerrilla gardening projects, where people took possession of public spaces, so that they could actively practice gardening and green their immediate living area.

Qualitative Reflection

Urban gardening projects have now become mainstream in many cities. The big advantage is the possibility for people without their own garden to grow vegetables, flowers etc. on a small scale. Additionally, from a social perspective, it is also a successful way to greet people in the neighbourhood and to network with them.

Quantitative Indicators

Figure 1.3.5. *Urban Community Garden in Vienna. (Credit: © Northoff).*

	Time Frame			Scale		Approach		Urban Acupuncture			Impact Level		
Category*	Temporary	Repetitive	Permanent	Small	Large	Top-Down	Bottom-Up	Intervention	Small Hack	**Replicability Level****	Geographical**	Environmental**	Social**
G	X	X		X			X		X	H	L	L	H

** G = Green; B = Blue; Y = Yellow; C = Circular; W = White*
*** S = Small, M = Medium, H = High*

“50 GREEN HOUSES”

Info / Link: https://50gh.at/

In the “50 Green Houses” project, two innovations were developed with BeRTA, the green facade module, and a specially developed online submission tool that facilitates the greening of buildings within the city.

Original hacking idea:

The precursors to this idea are the facades of partly abandoned buildings that have naturally been overgrown with plants

Quantitative Indicators

Figure 1.3.6. *BeRTA, the green facade module, 50 green houses, Vienna (Credit: © GRUENSTATTGRAU).*

	Time Frame			Scale		Approach		Urban Acupuncture			Impact Level		
Category*	Temporary	Repetitive	Permanent	Small	Large	Top-Down	Bottom-Up	Intervention	Small Hack	**Replicability Level****	Geographical**	Environmental**	Social**
G			X		X	X		X	X	H	M	M	L

** G = Green; B = Blue; Y = Yellow; C = Circular; W = White*
*** S = Small, M = Medium, H = High*

Qualitative Reflection

Climbing plants and green facades contribute to a positive microclimate in summer by keeping both building surfaces and thus the street space cooler. The special aspect of the BeRTA green facade is its modular structure: All components are coordinated with one another and can be flexibly adapted to almost any location and facade.

Romania: Bucharest, Alba Lulia, Timișoara, Cluj Napoca

Cities have traditionally hosted few green and play spaces, depriving people and children of opportunities to interact with nature, which can often be re-invigorated through gardening. As such, some schemes address urban farming in Bucharest, Alba Iulia & Timișoara as a way of addressing this problem, and so that people of all ages can learn about food and farming and opportunities to interact with the nature.

Bucharest

Bucharest is the capital and the largest city of Romania, as well as its cultural, industrial, and financial centre. It is located in the southeast of the country, on the banks of the Dâmbovița River, less than 60 km (37.3 mi) north of the Danube River and the Bulgarian border. In recent years, the city has been experiencing an economic and cultural boom and its green spaces and heritage has to some extent been abandoned and neglected. In 2016, the historical city centre was listed as "endangered" by the World Monuments Watch.

Alba Iulia

Alba Iulia is of great significance for Romania, as it hosted the Great National Assembly of December 1, 1918, when Transylvania was united with Romania and the foundations of the Modern Romanian Unitary State were laid. The city has many other attractions, such as its Vauban fortress. Thus, actions on the revitalization of the cultural and historical heritage of the city, with emphasis on capitalizing on existing resources at the local level, are just some of the activities carried out by Alba Iulia in recent years, including the authority that supported the Gradinarescu project.

Timișoara

Timișoara, the 2021 European Capital of Culture, is one of Romania's city with an economic boom. Thus, different initiatives were developed by the community as active tools in the socio-urban environment of Timisoara, which aims to stimulate public interest in local urban conditions and to promote citizens' rights over public spaces.

Cluj Napoca

Located in northwestern Romania, Cluj-Napoca is the most important city in the region of Transylvania. The country's fourth-most populous city is the economic hub of the region, home to a half-million inhabitants in the metropolitan area and it is also home to the second largest campus of universities within Romania with 12 universities and an estimated 80,000 students. In the last few years, Cluj-Napoca is developing as a smart city with initiatives both from the administration and from the community.

GRĂDINĂRESCU

Info / Link: https://gradinescu.ro

The Grădinescu project is developed and coordinated by the Romanian Permaculture Research Institute (NGO) together with Kaufland Romania. The project started in Bucharest with 2 gardens on Kaufland supermarket plots and grew into a network of urban gardens (as from 2016) and urban farms (as from 2020) in different Romanian cities. The urban gardens are developed with the local communities and are located on the roofs of Kaufland stores (3), in parking lots, behind shops (4), and in schools in Bucharest (2), and the most recently implemented, in the Fortress of Alba Iulia Municipality and Timișoara.

Original hacking idea

The project coordinators help local NGOs and communities to fill the urban gaps in their cities and neighbourhoods with urban gardens based on permaculture principles that contribute decisively to the healing of the urban fabric, social contexts, returning a degree of self-sufficiency and food sovereignty to local citizens.

Qualitative Reflection

Community garden projects are based on permaculture principles, techniques and methods within all (design, implementation or maintenance) phases of the project which include such innovations as green energy and hydroponic agriculture. These gardens have managed not only to produce healthy food, but also to connect neighbourhoods, bringing people closer to the land, in more united communities of consumers through different seasonal social/neighbourhood events.

Quantitative Indicators

Figure 1.3.7. *The fortress garden, Alba Iulia.*
(Credit: https://gradinescu.ro/2018/12/01/gradina-din-cetate-gradinescu-alba-iulia/).

Category*	Time Frame			Scale		Approach		Urban Acupuncture		Replicability Level**	Impact Level		
	Temporary	Repetitive	Permanent	Small	Large	Top-Down	Bottom-Up	Intervention	Small Hack		Geographical**	Environmental**	Social**
G / Y		X	X	X	X		X	X		H	H	M-H	H

** G = Green; B = Blue; Y = Yellow; C = Circular; W = White*
*** S = Small, M = Medium, H = High*

SOMEȘ DELIVERY

Info / Link: http://somesdelivery.ro

Although probably the most important natural resource of Cluj-Napoca, the river Someș has been neglected and underused by the city for too long. The Someș is in fact not even a river; in the local Land Register it appears as the spillway canal of the Gilău reservoir dam 30 km upstream. A technicality that has been blocking negotiations on the social use of the river for years. This initiative is a wonderful example of a local community and its recovery of river corridor, as the promoters of the project have explained.
Someș Delivery has been an independent project since 2015 that challenges and tests ideas for the integration of Someș River in the life of Cluj-Napoca through an exploratory, experimental approach and public involvement. It is an interesting project in terms not only of the process involved and social mobilization, but also the proposed solutions. Thought out on a long-term basis, each year it addresses another segment of the river, which it analyses from a multidisciplinary perspective and in which it acts on four components: space, community, events and environment (potential and problems identification of each segment; testing through temporary interventions planning ideas). The interventions are kept on site for several months so that people can interact with them in their daily lives. The proposal is meritorious in that its concern is to mobilize residual spaces for the benefit of local inhabitants. This approach constitutes the conceptual projective support of some procedural interventions which, located along the Someș corridor, constitute a succession of pleasant environmental spaces, for the benefit of each neighborhood and its inhabitants.

Original hacking idea

Someș Delivery is an annual programme of events with specific ephemeral manifestations that can inspire permanent usage and that responds to neighbourhood needs. It is linked to the place and the river and generates public debates on the role of the river Someș in city life.

Qualitative Reflection

Someș Delivery is a project that encourages residents to experience the river banks through temporary interventions. It underlines the potential of the waterfront from the viewpoint of city restorative practices, linking together aspects of Someș to gain a much stronger character, which it is still working towards.

Quantitative Indicators

Figure 1.3.8. *Someș Delivery installation. (Source: https://www.facebook.com/SomesDelivery/ https://www.facebook.com/SomesDelivery/photos/pcb.3767982076552361/3767977929886109/)*

Category*	Time Frame			Scale		Approach		Urban Acupuncture		Replicability Level**	Impact Level		
	Temporary	Repetitive	Permanent	Small	Large	Top-Down	Bottom-Up	Intervention	Small Hack		Geographical**	Environmental**	Social**
B / G	X	X		X			X	X		H	M	M	H

** G = Green; B = Blue; Y = Yellow; C = Circular; W = White*
*** S = Small, M = Medium, H = High*

Hungary: Budapest

REHYDRANT IVÓCSAP

Info / Link: https://rehydrantproject.com; http://ivocsap.hu/

This project, developed in 2013 by AW Architecture, is an innovative and creative initiative that transforms the fire hydrants of the city of Budapest during the hot summer season into drinking fountains in response to the city's heat island problem and with the idea of enlivening public spaces through the provision of free drinking water.

Original hacking idea

The project is motivated by an absence of public drinking fountains. The tap design quickly, easily and inexpensively transforms fire hydrants into public drinking fountains, without affecting the primary purpose. ReHydrants provide quick and easy access to drinking water in public spaces in safe and efficient ways.

Quantitative Indicators

Figure 1.3.9. *ReHydrant (Source: http://ivocsap.hu/).*

Category*	Time Frame			Scale		Approach		Urban Acupuncture		Replicability Level**	Impact Level		
	Temporary	Repetitive	Permanent	Small	Large	Top-Down	Bottom-Up	Intervention	Small Hack		Geographical**	Environmental**	Social**
B / C		X	X	X			X	X	X	H	M	L-M	H

** G = Green; B = Blue; Y = Yellow; C = Circular; W = White*

*** S = Small, M = Medium, H = High*

Qualitative Reflection

The impact is significant and the concept is recommended for governments and local water utility companies, as a quick and easy way to provide public drinking fountains wherever unavailable in the city, inviting engineers, municipal city services, and other experts to collaborate. It is a good tool to address urban heat issues.

Spain: Madrid

Since the 2008 economic crisis, Madrid has become the epicentre of major political and urban transformation. These changes can today be witnessed in the *Laboratorios ciudadanos* (citizen laboratories) set up in vacant city spaces. Rather than resulting from any urban-planning strategy, they seem to have materialized from the spontaneous impulses of ordinary citizens and highly qualified groups working together in such areas as a collaborative economy, the digital technology, urban ecology or social urbanization. These laboratories are fertile grounds for *urbanismo de codigo abierto* (open-source urban planning), collectively rethinking common urban strategies. The challenge is to (re)make the city *in situ*, using neighbourhood resources rather than acting like public authorities or previously-established municipal groups. Citizen laboratories use digital tools and "hacker ethics" to reclaim Madrid's vacant spaces and to coproduce within them. Some twenty citizen laboratories have emerged over the past few years, including Esta es una plaza, Campo de la Cebada or ECO-VALLE Mediterranean Verandahways. Each specializes in a particular field, such as agriculture and urban economy, social and cultural integration, collaborative art and the digital economy.

ESTA ES UNA PLAZA

Info / Link: http://estaesunaplaza.blogspot.com/p/dossier.html

This project is an initiative of Madrilenians that started in December 2008 with the aim of assuming public responsibility for the management of a municipally owned plot, located in Madrid. Intended at the outset for commercial use, it had lain abandoned for over thirty years, until it was converted by the project into a space for responsible neighborhood use.

Original hacking idea

Esta es una plaza was an outcome of the workshop *Intervenciones en espacios vacíos de la ciudad* (Interventions in empty spaces in the city), organized by the *Urbanización* collective in collaboration with *La Casa Encendida*. A specific action at the workshop was the proposal to transform the site into a green space for alternative leisure and collective enjoyment. A proposal that responded to neighbourhood needs detected in a preliminary study before the workshop among residents and neighbours. During the brief duration of the workshop, on-site interventions removed accumulated garbage and debris and mapped some of the projected areas for its future development. Once the initiative was underway, the initial steering group - mostly architects, artists and biologists – that had set up the workshop in unison with those neighbours who had joined the process and whose willingness to support the action gave it greater scope and durability, registered the relevant papers for the transfer of the site from its proprietor, Madrid City Council. To do so, the first step was to form a Cultural Association with the existing name of the project: *Esta es una Plaza*. Their aim was to make this specific action a larger animated project with a will to experiment and work through a process of self-management and public participation.

Qualitative Reflection

The challenge that was posed of working in a coordinated and voluntary way to consolidate a collaborative space open to citizens is now a reality. A space that throughout successive interventions and activities in these years of activity has been transformed from a vacant lot into a landscaped, quiet and pleasant space for the enjoyment of children and adults, which provides the possibility of alternative leisure and recreation, an atmosphere of encounter and coexistence. The project developed in *Esta es una plaza* is a way of inhabiting the city in a more humane and inclusive way while respecting the environment. A living and formative space that has generated recognition and interest from university and cultural spheres and that perceives itself as a daily event built upon self-reflection, participation and consensus.

Quantitative Indicators

Figure 1.3.10. *Esta es una Plaza Project. (Source: http://estaesunaplaza.blogspot.com/p/dossier.html).*

Category*	Time Frame			Scale		Approach		Urban Acupuncture		Replicability Level**	Impact Level		
	Temporary	Repetitive	Permanent	Small	Large	Top-Down	Bottom-Up	Intervention	Small Hack		Geographical**	Environmental**	Social**
Y		X	X		X	X			X	H	H	H	H

** G = Green; B = Blue; Y = Yellow; C = Circular; W = White*

*** S = Small, M = Medium, H = High*

CAMPO E LA CEBADA

Info / Link: https://www.publicspace.org/works/-/project/g362-the-barley-field

The Campo de la Cebada came to life in October 2010, when the city decided to demolish a sports complex in the La Latina area. Residents and neighbourhood groups worked together to create and manage an area dedicated to neighbourhood social and cultural initiatives, with shared gardens and sports fields. Benches and bleachers were designed and made from recycled materials, using free designs and fab-lab tools. Participants even created a geodesic dome 14 metres in diameter for hosting different cultural and social events.

Original hacking idea

The sports centre was demolished in 2009. It was the only sports facility in the neighbourhood but, owing to the onset of the economic crisis, no investment to construct a replacement was forthcoming. A vacant, sunken area of 2300 square metres, surrounded by an opaque fence within the very heart of the historic centre of the city, was left in limbo, waiting for better times. After a year of silence, the empty space was the object of an installation conceived as part of the "La Noche en Blanco" (All-Night Long) initiative, which periodically engages in temporary occupations of public space, so as to reinvent the relationship between Madrid and its public. The space became the venue of a "Rain Forest" and an open pool which, for ten days that summer, were the pride and joy of the La Latina neighbourhood.

Quantitative Indicators

Figure 1.3.11. *Campo de la Cebada (Source: https://www.publicspace.org/works/-/project/g362-the-barley-field)*

Category*	Time Frame			Scale		Approach		Urban Acupuncture		Replicability Level**	Impact Level		
	Temporary	Repetitive	Permanent	Small	Large	Top-Down	Bottom-Up	Intervention	Small Hack		Geographical**	Environmental**	Social**
Y		X	X		X	X			X	H	H	M	H

** G = Green; B = Blue; Y = Yellow; C = Circular; W = White*

*** S = Small, M = Medium, H = High*

Qualitative Reflection

"El Campo de Cebada" is an experiment project that has many lessons to offer for administrators, specialists and citizens. Administrators would do well to take note of its spontaneity, challenging the official channels with a committed initiative notable for its transparency, participation and social inclusion. Fully aware of its provisional status, surprisingly the project grew out of a dispute with the administration, though at the end of the project it had established a symbiotic relationship with the administration, in a win-win situation for everybody. Moreover, its fertile, cheerful austerity has established a valuable precedent that can repeated anywhere in cities so often replete with projects that have been delayed or abandoned as unviable. As for the local residents, "*El Campo de Cebada*" is a way of speaking out against indifference, proof that it is possible to shape a city together, that there is life beyond top-down urban planning. After having existed as a totally built-up site for decades, this space has reverted to its former use as a public square, now an open-air area available for community use. Rather than an indefinitely abandoned, inaccessible empty space, it has achieved the status of a public space all senses of the word. Everyone would willingly confirm that this area is enjoyed in direct proportion to the extent to which the space is shared.

ECO-VALLE MEDITERRANEAN VERANDAHWAYS

Info / Link: https://ecosistemaurbano.com/es/eco-bulevar/

The bioclimatic Boulevard of Nature was constructed by Ecosistema Urbano Studio to promote the use of public open spaces in a residential area of Vallecas (Madrid). Three cylindrical structures or 'Air Trees' were built along the boulevard. The South 'Multimedia Air Tree' was built with a Liquid Crystal Display screen surrounding the cylinder. The central 'Air Tree' is surrounded by an interior plant envelope. The North 'Evaporative AirTree' is built with sixteen wind towers and evaporation systems on the top. The aim of this project is to promote the concept of a walkable city, improving the thermal comfort of pedestrian areas in a new residential neighbourhood located on the outskirts of Madrid.

Original hacking idea

The use of open spaces in Mediterranean countries is one of its cultural characteristics. In these regions, the hot season, a period of high temperatures and solar radiation, reduces outdoor thermal comfort. Shade, vegetation, ventilation and water fountains are necessary to mitigate these conditions and to promote the use of such areas. In 2005, the Municipal Authority for Housing and Land Use of Madrid (EMVS) implemented the "ECO-VALLE Mediterranean Verandahways" project (LIFE02 ENV / E / 000198). Its aim is to develop a bioclimatic urban design that combines thermal conditioning strategies in open spaces with the promotion of public spaces as social exchange areas in the new Expansion of Vallecas. In 2007, the winner of the competition, the architectural studio Ecosistema Urbano, constructed a semi-pedestrian boulevard with three recyclable and exportable cylindrical structures called "Air Trees". These structures were monitored and simulated to assess the improvement that the integration of evaporation systems, ventilation strategies and shade elements produce on the thermal comfort of the boulevard. The 'Air Trees' can be re-installed at similar locations or in other types of situations requiring urban activity or reactivation.

Qualitative Reflection

The Boulevard of Nature in Vallecas is an effort to tackle the problem of the urban sustainability in two complementary ways: both environmentally and socially. This project is an initiative that improves the thermal conditions of an outdoor space through the integration of bioclimatic strategies and enhances the relationships between citizens through community recreation and leisure areas.

Quantitative Indicators

Figure 1.3.12. *Three cylindrical structures or 'Air Trees' (Source: Ecosistema Urbano Arquitectos).*

Category*	Time Frame			Scale		Approach		Urban Acupuncture		Replicability Level**	Impact Level		
	Temporary	Repetitive	Permanent	Small	Large	Top-Down	Bottom-Up	Intervention	Small Hack		Geographical**	Environmental**	Social**
G		X	X		X	X		X	X	M	M	M	M

** G = Green; B = Blue; Y = Yellow; C = Circular; W = White*

*** S = Small, M = Medium, H = High*

Luxembourg

Luxembourg is the capital city of the small country of the same name. Renowned for its banking center, it should not be forgotten that Luxembourg City is also the seat of many European institutions. The centre of the country is home to no less than 170 different nationalities who have chosen to live in a city in the heart of Europe. With places of artistic expressions, such as museums, theatres, and concert halls, Luxembourg's cultural program reflects the image of its citizens: multilingual, multicultural, creative, and eclectic. In fact, the Old City of Luxembourg has long been a UNESCO World Heritage Site. One-third of the surface of the city is covered with landscaped green spaces.

THEATERPLAGE

Info / Link: https://www.wort.lu/fr/luxembourg/la-place-du-theatre-les-pieds-dans-le-sable-5d2f52dbda2cc1784e348153

Since 2018, in Luxembourg, the slightly abandoned Place du Théâtre has been transformed every summer, as part of an ephemeral "placemaking" project, into an attractive and convivial space, inviting people to stay there, play board games, rest on garden furniture, or participate in educational workshops offered by the Spillmobil de Young Caritas, a real little beach was set up on the square between July and September. Generally, the structure has a large 350 m2 sand box, textile "feet-in-the -sand" deck chairs, parasols, several plants, a supply of beach toys, an inviting piano waiting for would be pianists and a pétanque court.

Original hacking idea

While in 2018, a lawn invited buyers to rest, play board games, sit on garden furniture and participate in educational workshops offered by Spillmobil de Young Caritas, between July and September 2019 a large sand pit was introduced in one part of the square.

Quantitative Indicators

Figure 1.3.13. *Title Theaterplage, Luxembourg*
(Source: https://www.wort.lu/fr/luxembourg/la-place-du-theatre-les-pieds-dans-le-sable-5d2f52dbda2cc1784e348153).

	Time Frame			Scale		Approach		Urban Acupuncture			Impact Level		
Category*	Temporary	Repetitive	Permanent	Small	Large	Top-Down	Bottom-Up	Intervention	Small Hack	**Replicability Level****	Geographical**	Environmental**	Social**
G	X	X		X		X		X		H	H	L	H

** G = Green; B = Blue; Y = Yellow; C = Circular; W = White*

*** S = Small, M = Medium, H = High*

Qualitative Reflection

The project shows a better use of space, offering more leisure and social areas for the population. The project was implemented in the city centre of Luxembourg, although it could be replicated in other areas of the city and in other municipalities. In addition, it brings verdant greenery to the city centre with a low environment impact.

Brazil: São Paulo, Belo Horizonte

São Paulo

São Paulo is a typically urban multifaceted metropolis. It is at once the most important economic centre in Brazil and a Latin American cultural capital, offering its unique combination of leisure, knowledge, and entertainment. The city, like Brazil itself, contains a multi-ethnic mix of different peoples, whose added heritages form the identity of the Paulistano people today. Cultural signs of over 70 nationalities can be identified in its architecture, cuisine, sports, and many other aspects of the city. There are over 12 million inhabitants living in São Paulo (IBGE, 2019a). Among its buildings, restaurant areas, shopping malls, centres for different types of shopping, and some parks and green areas can be found. Against this background, the Ruas Abertas project has come to represent a great conquest for civil society: the occupation and the reappropriation of the city.

Belo Horizonte

Belo Horizonte, the sixth-largest city in Brazil, is the capital of the southern state of Minas Gerais, with a population of approximately 2.5 million (IBGE, 2019b). This makes it the eighteenth largest city in the Americas. It is the first modern city planned in Brazil, built in the 1890s to replace Ouro Preto as the capital of Minas Gerais. The city presents a mixture of contemporary and classic buildings and hosts icons of modern Brazilian architecture, most notably the Pampulha Complex, designed by Oscar Niemeyer.

PROGRAMA RUAS ABERTAS

Info / Link: https://www.paulistaaberta.minhasampa.org.br/

The Ruas Abertas project aims to promote an expansion of public spaces, with more options for leisure, coexistence and recreation among the population. Its measures clarify the rules for the management of open spaces for the inclusion of new roads and squares in other programs incorporated by the city. Paulista Aberta was a great achievement of civil society in São Paulo, through the mobilization of collectives, NGOs and the public. Since 2014, Minha Sampa, together with several organizations, mobilized for the pedestrianization of Avenida Paulista on Sundays and holidays. The victory came in June 2016, when Mayor Fernando Haddad's decree was published, officially creating the Paulista Aberta and the Programa Ruas Abertas that promotes street openings on Sundays and holidays for people. It is a policy that makes the city more friendly, bringing people closer to each other. Several public hearings were held in all sub-city councils, in order to consolidate the program. The result of this process was the opening of 29 streets within different districts. The intention of the law enacted today is that all 32 sub-city councils have at least one open street.

Original hacking idea

A document approved in 2007 stipulated that the avenue would only be closed three times a year - which normally happens on New Year's Eve, the São Silvestre race and the Gay Parade. Over the years the appropriation of space is done through parties, occupations, undersigned and organized movements - cyclists, partygoers, sportsmen, naturalists, playboys, hipsters, the middle, lower and upper classes, the community in the periphery, all compete in their way with their goals, for a place in the concrete. Since October 2015, Paulista Avenue has been closed to vehicles and opened to pedestrians and cyclists every Sunday, from 10am to 6pm. At the time, the decision was made by the municipal administration despite the controversy with the Public Ministry of São Paulo. They even proposed that a lane of the road should be cleared for vehicles - which was not accepted by the City Hall. In 2016, a municipal decree from the City of São Paulo officially closed the Avenida Paulista to cars on Sundays and during holidays. Following this regulation, the pedestrianization of roads in this programme is now a permanent feature as well as others, such as the Parklets and the 24-hour Streets.

Quantitative Indicators

Figure 1.3.14. *Avenida Paulista aberta. (Credit: © Marcela Kanitz in https://www.archdaily.com.br/br/928149/paulista-aberta-os-impactos-para-visitantes-e-moradores-apos-quatro-anos-do-programa).*

Category*	Time Frame			Scale		Approach		Urban Acupuncture		Replicability Level**	Impact Level		
	Temporary	Repetitive	Permanent	Small	Large	Top-Down	Bottom-Up	Intervention	Small Hack		Geographical**	Environmental**	Social**
Y	X	X		X	X		X	X	X	H	H	L	H

** G = Green; B = Blue; Y = Yellow; C = Circular; W = White*

*** S = Small, M = Medium, H = High*

Qualitative Reflection

The closure of Paulista is a public policy measure with the objective of the population taking over the city and increasing leisure spaces. A policy that makes the city more friendly and brings people closer to each other. This measure can be implemented in any city that needs to increase its leisure areas wherever they were not included in earlier city planning. These urban hacks show how the population reclaim their spaces within the city, which are only legally reclaimed some years down the road.

FEIRA HIPPIE

Info / Link: https://feirahippie.com/

The official name is Feira das Artes, Artesanato e Produtos de Variedades de Belo Horizonte. Some people call it the Afonso Pena Fair, the place where it all happens. Hippie Fair is the local name, a reference to its origin, in 1969, when students of plastic arts went to Praça da Liberdade to exhibit their works of art. The Hippie fair attracted more and more visitors and, in 1991, it was transferred to Afonso Pena Avenue. It is today the largest open-air fair in Latin America. The almost 100 thousand visitors can still purchase from every kind of business: typical handicraft from Minas Gerais, clothing, leather goods and bijouterie at affordable prices. The food and drink part of the fair is an attraction apart, with the presence of typical foods from Minas Gerais including *espetinho* (brochettes) and *acarajé* (fritters).

Original hacking idea

In 1969, students of plastic arts went to Praça da Liberdade to exhibit their works of art, an event that metamorphosed over the years into the Hippie fair that has since then attracted more and more visitors. In 1991, it was transferred to Afonso Pena Avenue. In 1973, it was officially recognized by the City Hall of Belo Horizonte. In 1991, the Hippie Fair - a name affectionately given by the population and visitors to the arts and handicraft fair first held at Praça da Liberdade - and other handicraft fairs that had sprung up throughout the city were all transferred to Afonso Pena Avenue, in downtown Belo Horizonte, giving rise to the largest open-air handicraft fair in Latin America.

Qualitative Reflection

The Brazilian street fair represents a peculiar experience of sociability and street use, an urban tradition made obsolete by the expansion of the automobile and modern retail, but which struggles to persist in the urban landscape.

Quantitative Indicators

Figure 1.3.15. *Feira Hippie (Source: https://www.soubh.com.br/noticias/turismo/feira-hippie-e-tradicao-que-esta-na-moda).*

Category*	Time Frame			Scale		Approach		Urban Acupuncture		Replicability Level**	Impact Level		
	Temporary	Repetitive	Permanent	Small	Large	Top-Down	Bottom-Up	Intervention	Small Hack		Geographical**	Environmental**	Social**
Y	X	X			X		X		X	H	H	M	H

** G = Green; B = Blue; Y = Yellow; C = Circular; W = White*

*** S = Small, M = Medium, H = High*

Poland: Gdansk

Gdańsk is a thousand-year-old, Hanseatic city with a maritime culture that is still present. A sea-port and the cradle of *Solidarinośĉ* (or Solidarity, the first independent Polish trade union in the Soviet bloc), known for its multiculturalism, openness and highly tolerant attitude (among post- socialist countries), it is often called the city of freedom. Over the past 25-years, the transition from a centrally planned Soviet bloc economy to an EC member state has had both negative and positive consequences. Many new investments have improved the quality of life and the built environment, in most cases supported by EU funds.

Over recent years, the level of civic engagement has also been increasing. There is also a growing number of bottom-up initiatives. Two examples of urban hacks/interventions, in line with this trend, are presented below: first dealing with air quality and with public spaces within the city. In this chapter, we also seek to analyse how local government is responding to such hacks and interventions and to establish whether current legal and organizational development frameworks within the city are ready to support and integrate them into an urban development agenda.

#THREECITYBREATHE

Info / Link: http://www.frag.org.pl/

Over the past five years, air pollution in the form of smog caused by transportation, industry and heating has become one of the most critical issues among Polish city dwellers. Although, Gdańsk has a much better bill of health than most other Polish cities, air quality issues nevertheless remain on the agenda. In Gdańsk alone, approximately 30,000 stoves are still used for heating, most without meeting any environmental standards. Atmospheric limits on carcinogenic benzopyrene are regularly exceeded and the average daily levels of PM10 particles during the heating season, are exceeded at all the measurement stations. Only one of existing stations in Gdańsk measures the more harmful PM2.5 particles. Activists from a local NGO, FRAG, took measurements of these particle levels in 2017 and 2018. They used the results of simple laser sensors to show that in some districts the annual average permissible standard was exceeded by up to 1000 percent. Even if these are not annual average results but those from single measurement, the fact is that such high concentrations of particles can have a negative impact on human health.

Original hacking idea

The aim of Project #threecitybreathe is to introduce and to implement networks of civic air quality meters that measure PM2.5 and PM10. Official monitoring does not provide enough data, as it would be important to have data from densely populated places or from the streets where children go to school. In this situation, groups of city activists from NGO Frag decided to act bottom-up. As the problem turned out to be important not only for them, they entered into a partnership with the WSB University, LPP SA company and the Miasto Wspólne association, and together started an air quality measurement program in the Tri-City area. In March 2018, thirteen Airly sensors were installed, to monitor the level of the most common air pollutants, i.e. PM2.5 and PM10 particles. They were placed in the areas were no official measurement stations are located. Airly sensors were given directly to the residents, who lived in those districts and are willing to participate in the project. In the next project workshop activity, all citizens of Gdańsk in attendance were able to assemble their own air quality sensor for use at home. They were all connected and results can be monitored through the webpage of the German LuftDaten initiative. It should nevertheless be mentioned that the quality of the self-made sensors was much lower than the Airly sensors of equal quality to those used within the city.

Qualitative Reflection

The first step towards a substantive debate on air quality within an agglomeration is undoubtedly proper diagnosis of the problem before actions may be taken to improve it. The network of citizen sensors (counting only Airly sensors) is twice as large as the existing regional and city public monitoring system, but it is in no way intended to compete with it. The assumption is that the new sensors are to complement the existing atmosphere monitoring network, giving a more complete picture of air quality in different neighbourhoods. In particular, in those places where no official measurements are recorded. The total number of sensors in the Tri-City, including the non-reference stations of the City of Gdańsk and Airly, has, as a result, doubled.

Threecity Breathe is one of awareness rising initiatives and, over recent years, awareness of the importance of air quality has been much higher among citizens of Gdańsk. As the city implemented a successful open-data policy in Gdańsk one of its important parts are data on air quality. One of the successes of this initiative is that the project seeks to integrate and to visualize data integration from all the sources – ARMAAG, City sensors and Airly sensor are now under development within the city of Gdańsk.

Quantitative Indicators

Figure 1.3.16. *Presentation of project during solidarity day (Source: https://www.facebook.com/stowarzyszenieFRAG).*

Category*	Time Frame			Scale		Approach		Urban Acupuncture		Replicability Level**	Impact Level		
	Temporary	Repetitive	Permanent	Small	Large	Top-Down	Bottom-Up	Intervention	Small Hack		Geographical**	Environmental**	Social**
W		X	X	X			X	X		H	L-M	H	M

** G = Green; B = Blue; Y = Yellow; C = Circular; W = White*

*** S = Small, M = Medium, H = High*

TARG WĘGLOWY (COAL MARKET)

Info / Link: http://targweglowy.ikm.gda.pl

With the transition to a neoliberal system, vehicle dependency among the inhabitants of all the Polish cites, including Gdańsk, has increased. This surfeit of cars is of course causing parking problems, which are specially pronounced in the historic city centre where narrow streets limit traffic capacity. Coal Market, a vital node in public network of open spaces within the Old Town of Gdańsk, was converted into main strategic parking lot for this area. Surrounded by medieval and renaissance structures, it is as if it were still living in the Middle Ages. Recently the discussion over future development of this plaza has started. This included various student workshops and competitions, which were organised to examine possible solutions.

Original hacking idea

In 2013, the main parking with almost 160 bays in the historic Old Town of Gdańsk was for 4 months transformed into a pedestrian space. Even before this action had started, protests from car drivers parking in Coal Market and employees of nearby institutions had been voiced. At the outset, the market was used for the annual Fair of St Dominic, although a temporary design project was prepared later on by the City Culture Institute.

The market was divided into various zones for relaxing, playing games, reading, and dining, as well as for the audience zone (an area for screening films). The zones were made of wooden decks, lined with natural grass, on which light cubic forms and deckchairs were placed. This urban beach became a very popular place both among residents and tourists throughout summer. There were many activities such as open-air yoga classes, weekend breakfasts, afternoon films and evening concerts.

Most importantly, in the central part of the square, an information and consultation pop-up pavilion was created, where everybody could express their opinion and submit ideas for the new development of the Coal Market. The slogan of the action 'The city for people' was connected with a well-known book that Jan Gehl[1] had written and had published that same year.

The aim of initiative was to open up to new possibilities and raise discussion on the future of the site. Aleksandra Szymańska, director of City Culture Institute, explained that 'the idea of proposing new activities at the Market was inspired by the ongoing discussion about the function it currently performs'. It became an important part of urban discourse on future development plans for the plaza.

Qualitative Reflection

Although there are no signs that the public expect permanent changes to the Coal Market, the parking is closed several times a year: three weeks during yearly St Dominic Fair and four weeks during the Christmas Fair.

The situation is unlikely to change until the construction of a new strategic parking, in a multistorey structure or underground. However, we can also observe attitudinal changes among local politicians, planners and gradually the general public, who start to understand the limitations of individual car-dependent use within a city. Its impact on air quality and congestion within urban spaces may cause even quicker transformation of the Coal Market.

Quantitative Indicators


Figure 1.3.17, Figure 1.3.17. *Temporary arrangement for the Coal Market.*
(Source: http://targweglowy.ikm.gda.pl/, photo. Bogna Kociumbas).

Category*	Time Frame			Scale		Approach		Urban Acupuncture		Replicability Level**	Impact Level		
	Temporary	Repetitive	Permanent	Small	Large	Top-Down	Bottom-Up	Intervention	Small Hack		Geographical**	Environmental**	Social**
G	X			X			X	X	X	H	S	S	M

** G = Green; B = Blue; Y = Yellow; C = Circular; W = White*
*** S = Small, M = Medium, H = High*

9 Take-aways: Smallness matters!

Cities are particularly affected by climate change. Global warming in densely built-up areas and a high proportion of sealed surfaces leads to heat islands and higher temperatures than in the surrounding countryside. People with lower incomes who do not have the opportunity to escape the heat of the city at least on weekends are particularly hard hit by climate change. "Small urban hacks" that help to improve the microclimate and the quality of stay in cities are therefore an essential social factor. They contribute to a positive microclimate in summer by keeping the building surface and thus the street space cooler. Many other positive aspects were also shown on different levels through the previous examples. Some aspects are summarized here:

- > Urban hacks draw attention to deficits which should be given more attention. They react to missing offers and try to fill these gaps within the city with small interventions.
- > Urban hacks are solution-oriented and are therefore valuable contributions for improving public spaces.
- > Liveable and lively cities need space for temporary initiatives – like urban hacks - as a catalyst for change.
- > Urban hacks can improve urban health and life quality
- > Urban hacking is a creative way of solving problems, led by citizens and associations.
- > They often revitalize abandoned places or neglected remaining areas and add a new use to them.
- > Urban hacks bring people - and especially children who grow up in cities - closer to nature and let them experience the growth of vegetables and food.
- > They open up new ways of accessing places and enable their use as leisure and recreational spaces.
- > They are geared towards social cohesion and bring neighbourhoods closer together.
- > Urban hacks use very simple means and resources are often already available on site; they combine them with new functions and possible uses.
- > Sometimes they restore uses in places that for whatever reasons have disappeared but, left a positive memory trace on the residents – such as temporary installations.
- > Urban hacks convey or link political messages, a pedagogical approach, an appeal for "change", references to missing "qualities" and try to generate awareness of the interventions.
- > They are trying to win back space in the city from traffic.

Hacks and Interventions are a diagnostic tool relating to what is going wrong in the urban environment/ development. They can be seen as an analogue feedback system. Integrations in urban agendas allow a broad range of proof-of-concept tools to tackle urban related issues.
Smallness matters! Urban hacks are adequate alternatives to solution-oriented and detailed-planning, but they site; also assumed to be a large intervention = "big impact credo". In particular, flexibility and adaptability, seen as the main properties of small hacks/interventions allow a fast context-related adaptation. But they are particularly sustainable:

- > Environmentally by offering easy to scale implementations
- > Socially by providing vehicles of structural-related citizen expression
- > In terms of governance, readjusting presumed planning-credos such as the detailed planned city development

Nevertheless, as we noted already at the beginning: "Urban acupuncture should be seen as an ongoing process. Interventions should not have rigid time frames, but should remain flexible, in order to adapt to the ever-changing needs of users. And, finally, as Casagrande (2015) considered: to let nature complete the work instead of man.

10 Reflection and Outlook

Urban Hacks can be seen as socio-cultural trends, socio-romantic endeavours of citizens and attempts at participatory tranquilisation from the traditional planning and governmental side. This chapter has expressed quite a controversial attitude towards such a common perception of acupunctural smallness.
Small urban hacks and acupunctural interventions have been part of the city since its creation. Always on the narrow side of the spotlight trying to make both hard and rigid structures of our urban environments

more agile. Agile for the people of the imminent neighbourhood and at the same time a structural reflection of what is missing in urban spaces. Reports on urban hacks and small interventions can be considered diagnosis tools. Easy to enact, fast to assemble and occasionally to examine.

Over the past decades, cities have been struggling to cope with advancing challenges regarding the climate crisis, acceptance by the broad civic society and infrastructural negligence. These issues are on the one hand commonly tackled with solution-oriented attempts, which act on broader and technology driven scales. The processes of the small-scale approaches are, on the other hand, open to testing and to readjusting mistaken directions in the management of the problem.

The specific examples and hacks are ambassadors of this smallness, using the gaps and cracks of the city in which to settle often with a temporary spirit. Furthermore, they are ambassadors of both the changes that are underway and the future scenarios that could impact on our urban living environments in a very decisive way. Finally, a matter of scale and scalability, which is not given yet.

After quite an exemplary list of what can be tackled through smallness, it is time to reflect on why this smallness, aside from the positive (micro)influence on microclimate, civic society and rewildering, is impacting on our planning methods. An approach to planning that has hardly ever changed since its emergence in the socio-cultural movements of the 50s/60s and one that could be seen as a driver for future innovation in current urban demand. An innovation driven by an interpretation of scale, agile governance and process-oriented planning behaviours. Time to reflect and time to act!

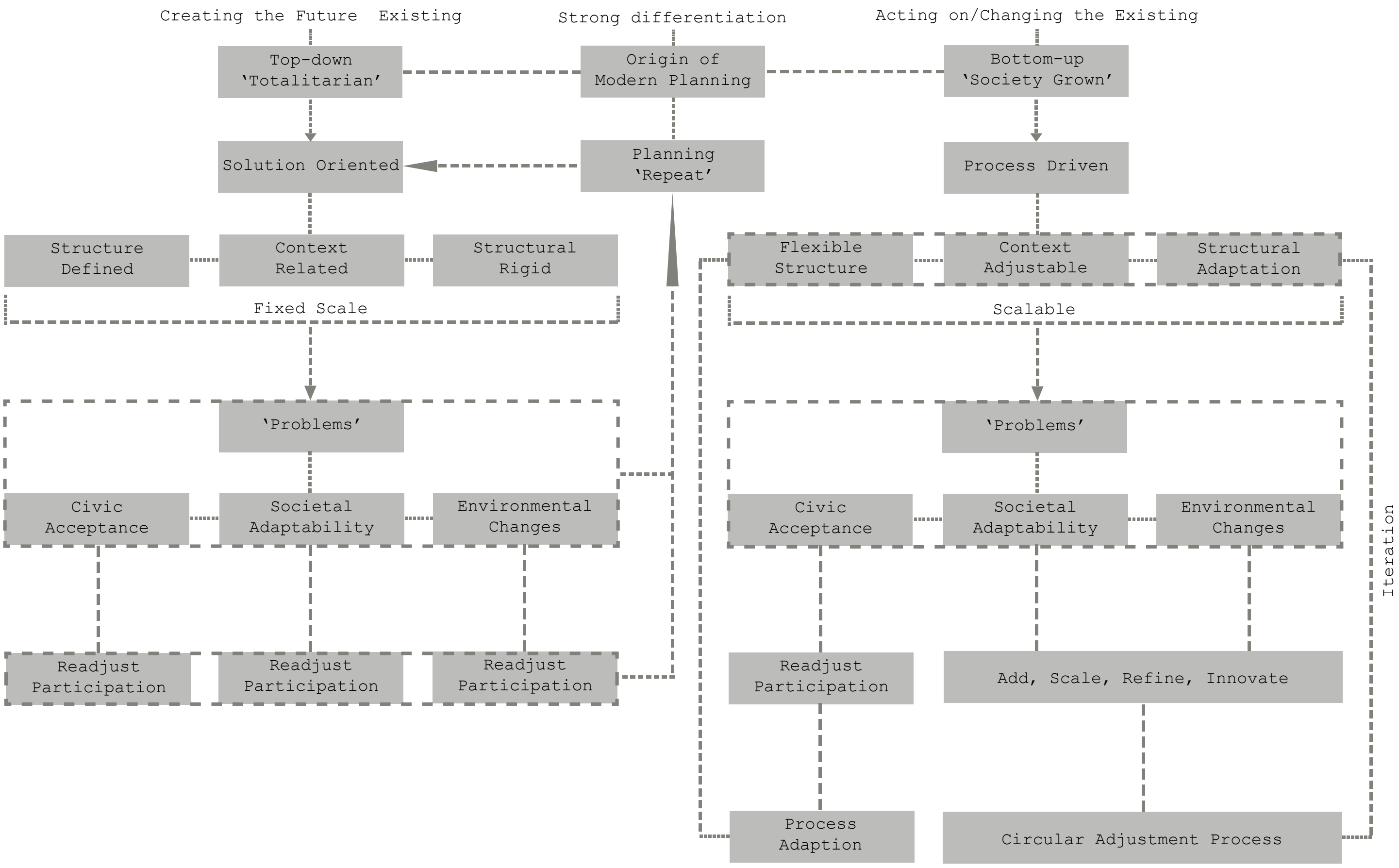

Figure 1.3.18. *Reflection Model (Credit: © David Calas).*

The above graph (Figure 1.3.25) aims to address the shift in paradigm when planning, so that common planning credos may be confronted with small urban interventions. The latter refers to the experiences reported in this chapter and in-depth examinations such as the evaluation of the selected urban hacks.
The initial strong differentiation of the shift in planning paradigms is the source of modern planning. Top-down as a government and rules-driven approach towards a future as it exists/establishing assumption and Bottom-up as a critical reflection of what exists, acting upon it to stimulate change. This initial differentiation is driven on one hand by the solution oriented, so-called totalitarian, planning approach, which repeats itself over and over again, and on the other hand by the process-driven iteration of planning attempts. Controversial attitudes, which act within the very same urban environment.
The difference in planning merges on its surface not just driven by the different approach, but also in its spirit. Therefore, fixed scale in structural definition, context relation and structural rigidity regarding solution-oriented planning runs contrary to the scalable flexible structure, adjustable context and finally structural adaptation. This reflection literally dissects the aim of small urban hacks, setting them in a broader planning discourse and reflecting the coherence of their 'Scale Jumping' through the case-study observations.
Since planning is always confronted with problems regarding civic acceptance, societal adaptability and environmental changes, the way of managing such issues will also reflect the initial planning credo. Having stated as much, top-down approaches and fixed-scale handling reverts to repetitive planning patterns, while bottom-up grown processes initiate an iterative route. Therefore, in the context of a parkour, a readjustment process is enacted facilitating adaptation and circular adjustment.
Small urban hacks have the ability to show such planning relations in a very concise way. In this chapter, the aim has been to reflect and to motivate broader actions, beside the common planning discourse, fostering the impact on our urban environments of the imminent challenges ahead. Urban hacks as small acupunctural actions inherit an ambassadorial role for future urban renewal.

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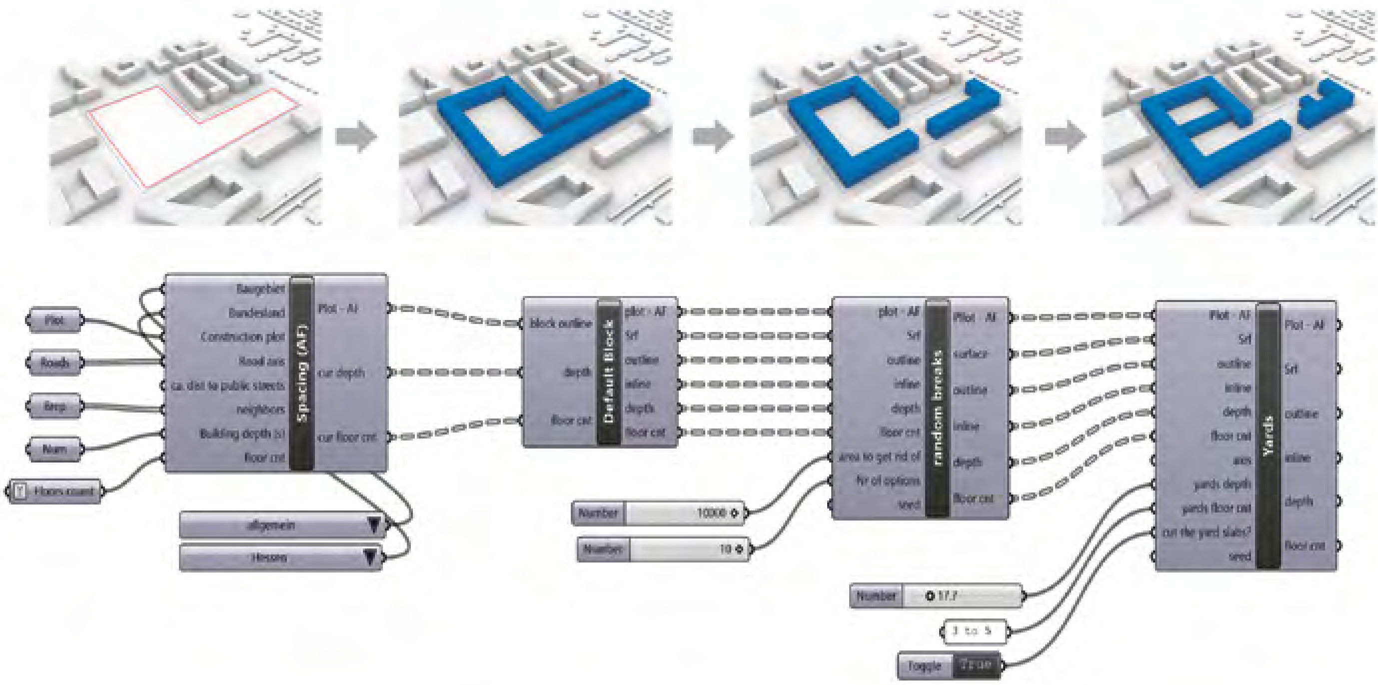
2. Tools, Platforms and Metrics



A parametric workflow for the generation of building volume alternatives on the basis of site rules and user inputs.
(Source: Osintseva et al., 2020).

2.1

Digital Tools to Support District Regenerative Design and Scale Jumping

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TABLE OF CONTENTS

Summary

In this chapter, digital environments and how they can support regenerative design at district level are discussed. It introduces the importance of digital tools both for linking domains, to achieve co-benefits, and for linking scales, to achieve scale jumping. The core revolves around the ways that parametric script integration can do the following: develop customized components that address specific issues of regenerative design, share data across domains and scales, resolve conflicting objectives, manage large amounts of data through optimization techniques and find smart design solutions via machine learning.

Addressing Scale Jumping

Scale jumping allows for single/multiple building components, building/s, space/s, district/s and cities for systematic connections with ecosystem services and infrastructure that operates in a cooperative state. Scale jumping allows designers to select and understand which scale is more effective at reaching regenerative targets. Digital Scale Jumping will enable us to make digital connections within the ecosystem, the built environment and with humans via the coupling of domain-specific scripts.

Digital Tools to Support District Regenerative Design and Scale Jumping

By Emanuele NABONI, Francesco DE LUCA

1 Regenerative Digital Design

Nowadays, responses to climate change, biodiversity and human health issues are seldom adequate in cities and districts design. Current design targets lean towards reductions of the negative impact, or at most aim for 'neutral' operational energy use. It is, however, becoming clear that newly constructed, and renovated districts need to move beyond reducing environmental impact; they must have positive ecological and social benefits. A holistic approach needs to be fostered that includes ecology, resilience and climate change awareness, circularity, regenerative use of space and health improvements.
Table 2.1.1 lists a series of design questions that apply to the design of a regenerative district organizing a series of benefits taken from standards such as the Living Building Challenge for Buildings and Communities (International Living Future Institute) and the WELL Community Standard (International WELL Building Institute). The table lists a series of tools that can address relevant regenerative design questions. The tools are selected from freeware Grasshopper Plug-ins that incorporate advanced software tools and that pave the way towards their use in regenerative design. Previous literature on simulation modelling (Naboni *et al.*, 2019) has highlighted how single tools or suites of tools are:

> offering minimal means for the modelling of ecosystem services.
> coping with a single ecological benefit at the time. In a few words, available simulation tools have been developed to deal with one isolated environmental issue.
> concerned with either the reduction of operational and embodied energy consumption and emissions; or the optimization of indoor thermal comfort and visual comfort; or the modelling of (water, air) flows within and around buildings. Other tools are exclusively for modelling outdoor thermal comfort and air pollution patterns.
> related to either the building or district energy performance, as if these were detached scales or only grouped for analysis and simulation of the outdoor or the indoor domains.

However, regenerative design calls for tools that are open to user customization, beyond the typical problems of architectural sciences, and that respond to a set of performance targets, among which those linked to the local ecosystem and human health. A shift that can no longer conceivably be explained by merely modelling the impact of design on either the ecosystem or health. In regenerative systems, it is necessary to couple models of one or more variables from the ecosystem (*e.g.*, local climate, local water cycles, the behaviour of other species, natural patterns of vegetation growth) and people (*e.g.*, behaviours, physiology). This is the next step in the integration of simulation domains and customization of environmental issues, achieved through parametric simulations. A concept that can be further explained by introducing two further relevant concepts: co-benefits and scale jumping. More specifically, we can operate within the parametric environment:

> cope with multiple ecological issues, simultaneously.
> couple various environmental problems in a holistic framework. These tools typically integrate energy simulation, daylighting, and embodied energy calculations.
> correlate buildings, districts and cities as a whole, and connect indoors to outdoors as a whole.

Table 2.1.1. *Co-benefit table and simulation tools.*

Macro-Area	Benefit	Examples of the regenerative question	Simulation Tool	Calculation Provided
Ecology	Increase biodiversity	How are habitats interconnected? What are their size and type?		
Resilience and climate change	Clean and controlled urban water	How much stormwater can be harvested on-site in an extreme event?	DeCodingSpaces https://toolbox.decodingspaces.net/#aboutToolbox	Analysis of water networks, analysis of water rundowns.
	Manage localized microclimatic conditions	In extreme hot-weather events, by how many degrees can your design reduce the local temperature	Ladybug Tools https://www.ladybug.tools/ Eddy https://www.eddy3d.com/	Weather data analysis, solar and daylight simulations, urban weather calculations, outdoor comfort analysis, building envelope heat/moisture transfer.
	Energy positive	How can the district become an energy positive district?	Ladybug Tools https://www.ladybug.tools/ ClimateStudio https://www.solemma.com/ClimateStudio.html TRNLIZARD https://www.food4rhino.com/app/trnlizard	Whole energy simulations at the building and district scale.
	Water positive	How can the district become a water positive district?		
Circularity	Looped material flows	How much of your project construction comes from circular processes? What materials and components are involved?		

Regenerative use of spaces	Maximize and activate existing spaces and buildings	How does the mix of functions operate? Where does it operate, and at what time of the day? How accessible are certain functions? How well utilized are spaces in prime locations?	UMI http://web.mit.edu/sustainabledesignlab/projects/umi/index.html Urbano https://urbano.io/	Daylight and energy simulations at the district scale, embodied energy, walkability, city network analysis.
	Mobility and pedestrian design	How do we place people-centric design at the forefront? How accessible are critical performance facilities for pedestrians and other transportation modes? How well are neighbourhood functions adjusted to through-movement and to-movement patterns? How simple, comfortable and attractive is it for pedestrians/cyclists to stroll or to cycle through the neighbourhood?	Urbano https://urbano.io/ DeCodingSpaces https://toolbox.decodingspaces.net/#aboutToolbox Numerical Urban Utility http://www.njstudio.co.kr/main/project/2016_MobilityEnergyConsumptionMITMediaLab/tool.html	Network analysis, vehicular and pedestrian connections and localization of amenities.
	Restorative built, green and blue spaces	How restorative green and blue areas are placed in a central value?	Pando https://www.researchgate.net/publication/341540817	Radiation fluxes, water uptake and drainage of tree canopies.
	Urban agriculture	To what extent are community gardening projects developed? How accessible are community gardens?	Harvest http://web.mit.edu/sustainabledesignlab/projects/Harvest/index.html	Urban food production, food yields estimate and associated energy use, water use and carbon emission

Health	Increase air quality	What is the effect of design on urban air quality?	Envi_Met (Ladybug Tools) https://www.envi-met.com/	Solar analysis, air pollution, building facade temperature, outdoor microclimate, vegetated walls, green rooftop, district water and energy balance.
	Increase thermal quality	How is psychological and physiological thermal comfort achieved?	Ladybug Tools https://www.ladybug.tools/ Urban Weather Generator (Ladybug Tools) https://urbanmicroclimate.scripts.mit.edu/uwg.php Climate Studio https://www.solemma.com/ClimateStudio.html DIVA https://www.solemma.com/Diva.html Alfa https://www.solemma.com/Alfa.html Envi_Met (Ladybug Tools) https://www.envi-met.com/ Swift https://www.ods-engineering.com/tools/ods-swift/	
	Achieve biophilia	Which of the 14 biophilic patterns are incorporated to achieve biophilia?	Alfa https://www.solemma.com/Alfa.html	

2 Co-benefits and Scale Jumping

The debate over digital environment support for regenerative design revolves around two key concepts: Co-benefits imply the sharing of assets in a creative, elegant and efficient design “move” that leads to energy flows, natural flows, living districts, and people to reach a cooperation status. This type of approach is quite unlike the one pursued by a single proposed sustainable strategy that is dealing with one topic at the time. The performative scope is, therefore, the imagination, development and simulation of a built environment “that is as connected as a forest ecosystem” (International Living Future Institute).
The achievement of co-benefits implies the creation of a new set of relationships that reinforce the state of health of natural ecosystems and humans, utilizing appropriate and creative design strategy, construc-

tion and technology. This challenge implies an in-depth knowledge of multiple fields, and therefore the involvement of several specialists. Furthermore, adequate parametric simulation tools must be used to develop integrated approaches and solutions within a set framework.

Scale jumping can facilitate systematic connections between single/multiple building components, building/s, space/s, district/s, cities and ecosystem services and infrastructure so that they operate in a cooperative state. Scale jumping allows us to select a scale on the understanding that it is more effective at reaching a given regenerative target.

Ideally, projects generate their energy, capture their water, and process their waste. Yet, the ideal scale for solutions is not always within the boundaries of a single project. Depending on the type of performance and the design strategy or technology, the optimal scale can vary when considering environmental impact, initial costs, operating costs and co-benefits across scenarios. When addressing these realities, projects must pursue scale jumping overlay so that multiple components, buildings, spaces and projects may combine in a cooperative state—sharing green infrastructure as appropriate and achieving environmental and social benefits as elegantly and efficiently as possible. The challenge for designers is certainly to embrace forward-thinking and multi-disciplinary knowledge in their design work, bearing in mind city, district, local, buildings and nanoscales.

The effects of small-scale interventions such as green roofs provide an example of scale jumping and the associated co-benefits. It is known that urban structures and green areas influence the urban climate at spatial scales. Roof greening as an individual measure of a single building has positive, but limited effects on the microclimate. On the other hand, if several roofs within an urban quarter are greened, the range of influence will already be more significant, and can positively affect large areas of the city. Suppose there are several quarters in a town that are sensibly combined. In that scenario, the effect reaches far beyond and can have a positive influence on the entire urban climate and surrounding area.

Thus, the sum of several small-scale changes can have a combined impact on the whole city and region. A similar discourse applies to biodiversity, in so far as green roofs can provide habitats for several species, and if they are sized and well placed within the city and in connection with rural suburbs, they allow for corridors that promote life. Twin benefits may be achieved in such scenarios: microclimatic and the creation of habitats that are promoting biodiversity within the city.

All these co-benefits and multi-scalar positive outcomes need to be modelled by linking several simulation engines, customized scripts belonging to several domains, several scales and using techniques that can process computationally intense calculations. It is not a trivial step forward, and the next section will trace some opportunities associated with the use of Grasshopper-based plug-ins.

3 Digital Parametric Environments

Achieving co-benefits and scale jumping encourages architects, scientists and designers to dig deeper into science, by looking at the integration of simulation data in design. While achieving co-benefits and scale jumping are a promising direction for sustainable design, new design tools and workflows need to be developed to put these ideas into practice. They are providing the digital integrated environments where tools that model climate, energy, nature, the built environment, and people behaviour maximize scale jumping strategies and benefits via the systemic coupling of physical domains of simulation and scales. The model scripts that are introduced here dynamically describe natural systems, materials, water, food, energy, carbon cycles, nutrients and goods (waste and pollution to air, water and land) and digitally couple the domains.

Digitally Connected Domains

There is a need for performance simulation methods capable of modelling the integration of ecosystems, buildings and inhabitants through the coupling of equations that capture the essence of scientific domains and their relations. To do so, parametric design, a process based on algorithmic thinking, enables the formulation of parameters and rules. Together, they define, encode and clarify the relationships between design intents and design responses (Figure 2.1.1).

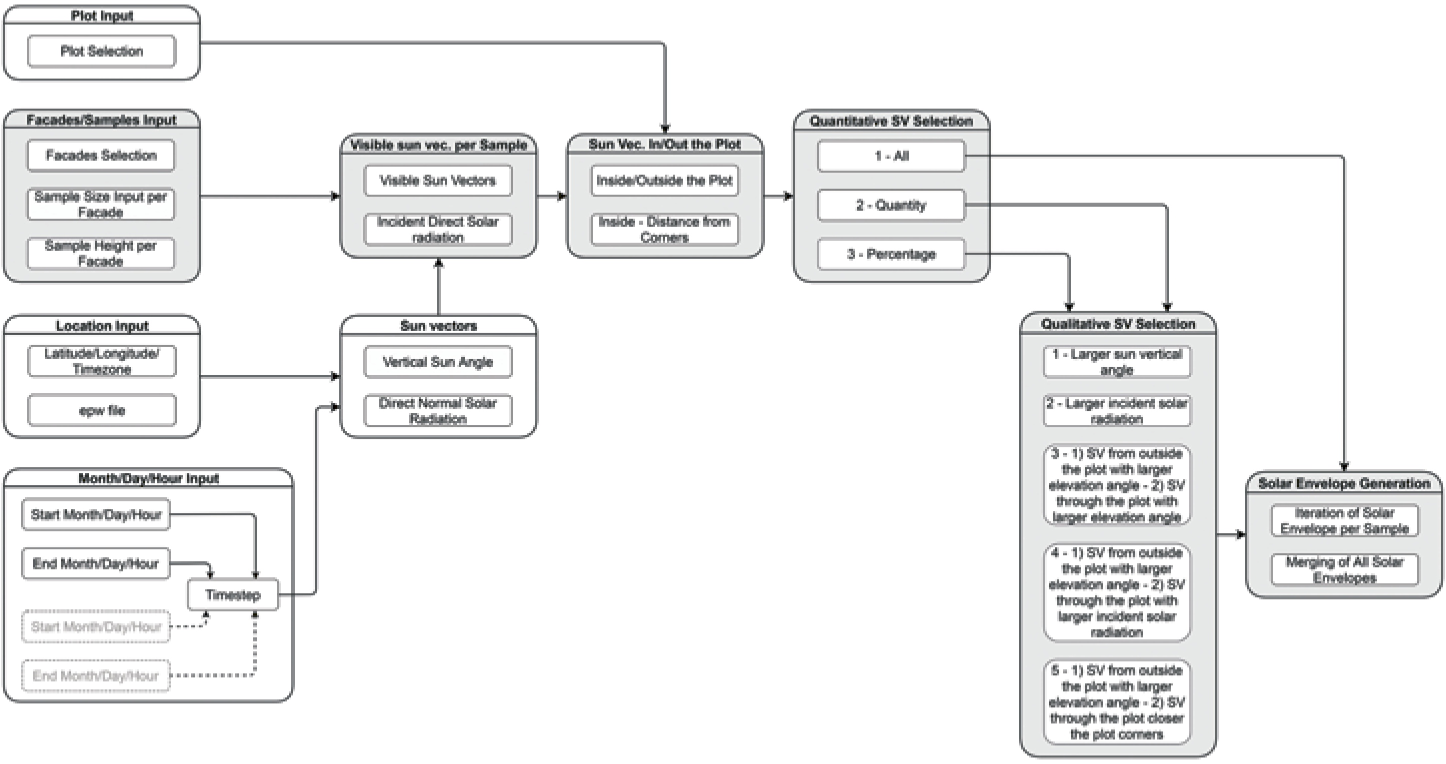

Figure 2.1.1. *Parametric design chart showing relationships between design intent, process and outcomes.* *(Source: Authors).*

A tool that gained prominence among others within the field of parametric simulation is the visual programming tool Grasshopper (Rutten, 2020). Grasshopper is a graphical algorithm editor tightly integrated with Rhino's 3D modelling tools. Unlike RhinoScript, Grasshopper requires no knowledge of programming or scripting, and designers can therefore build projects, whether awe-inspiring or straightforward.

Grasshopper is used for geometrical co-modelling of urban, natural environments and buildings, which are coupled with equations belonging to the domains of, among others, ecosystems, climatology, material sciences, synthetic biology, biology, botany, human comfort and physiology. Architects can model a large number of design options with Grasshopper, by linking problems and performances within various disciplinary domains, enabling the complexity of environmental issues to be modelled.

Grasshopper also provides access to information on geometries, materials and operations from domains that are not typical within architectural disciplines. An extensive list of regenerative digital design tools is shown in Table 2.1.1, including those used to develop strategies for biomimicry, positive energy buildings and the design of green-blue infrastructure. The field of application ranges from the single building to entire parts of the city. However, there is a boundless set of unexplored possibilities to integrate Grasshopper plug-ins into regenerative design practices and to negotiate new design targets appropriately, which up until today are mostly unexplored.

As new environmental parametric plug-ins pop up every day, this allows for the evaluation of multi-disciplinary health-related and ecological issues of regenerative design. Among all the available Grasshopper environmental plug-ins, Ladybug Tools (Sadeghipour and Pak, 2013) connects Rhino interfaces to validated environmental simulation engines, making it one of the most comprehensive available (Figure 2.1.2).

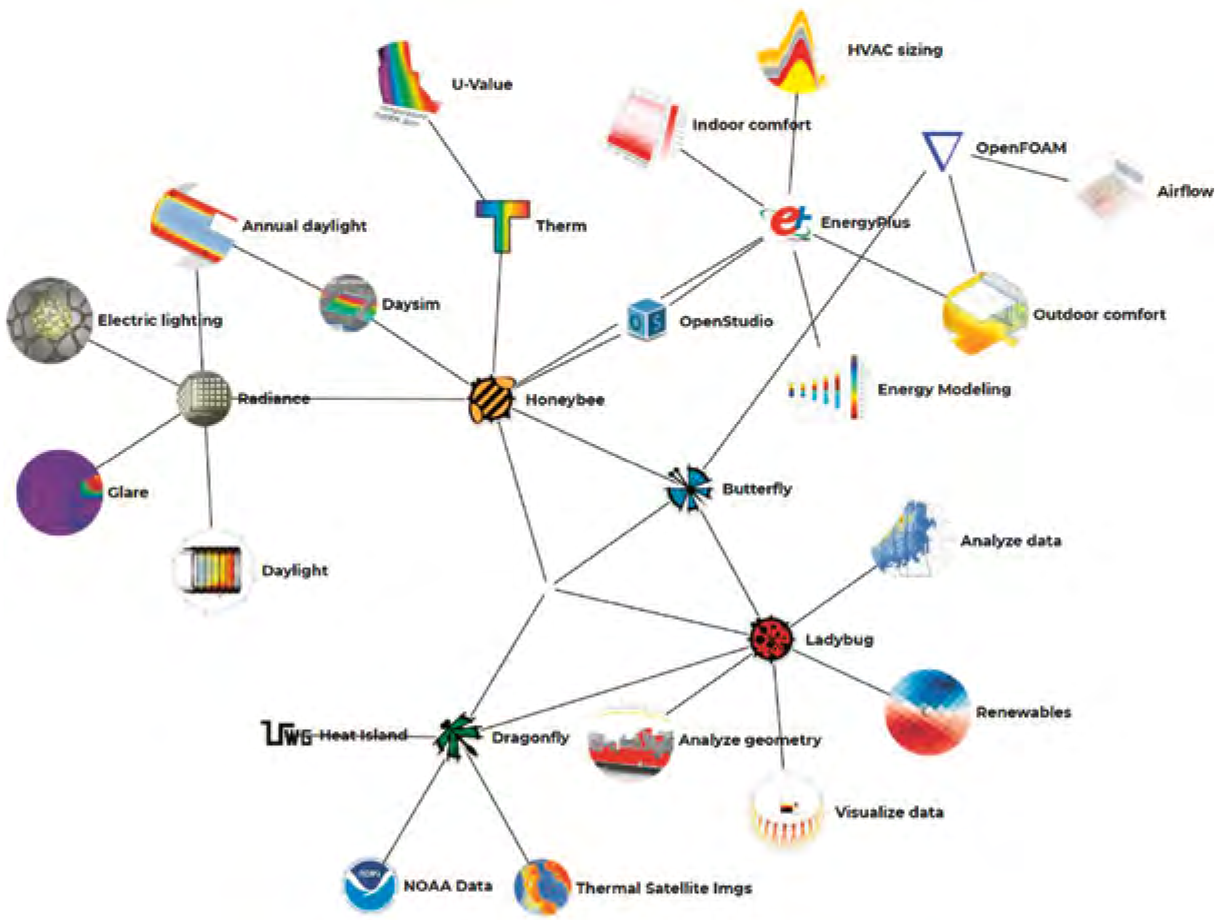

Figure 2.1.2. *The tool ecosystem of the Ladybug Tools environmental and regenerative design plug-in for Grasshopper. (Source: Ladybug).*

Custom Components

Custom components are used to include specific equations types when the existing script cannot perform particular functions and calculations. An in-depth step in the parametric design process is to use programming languages like C# and Python, to create customized components. Each new piece accepts multiple inputs and performs single and multiple operations.

The components contain models related to geometry, mathematics, physics, statistics, economy and behavioural sciences, and generic equations developed by the designer. The outputs of customized components are associated with projects underway. They include geometrical objects and data to generate model outcomes for the evaluation of design solutions, or as input parameters for other parts of the script, thus performing additional functions (Figure 2.1.3).

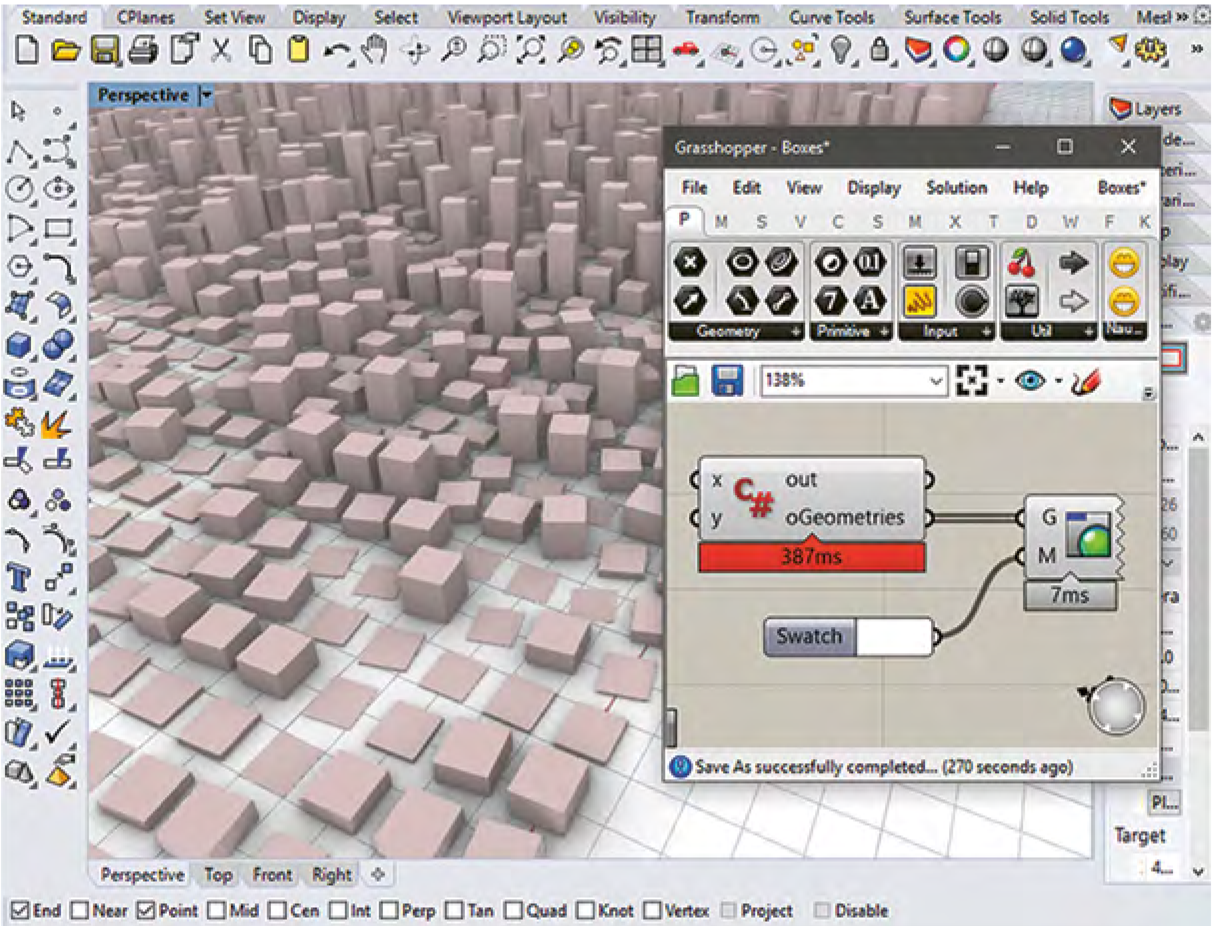

Figure 2.1.3. *Arrays of objects based on data and relational forms realized through a customized component written in C# in Grasshopper. (Source: Long Nguyen).*

Coupling

Coupled scripts are developed for tasks and stages of the design and planning process. Parametric design establishes the rules of a generation of building and urban forms, relating these with design concepts, specific site constraints, and local building regulations, *e.g.,* maximum height, FAR (Floor-to-Area-Ratio) and setbacks. Scripts are written to link building massing and urban layouts with initial floor plan division in perimeter zones and core zones, and quantification of glazed area (Window-to-Wall-Ratio and Window-to-Floor-Ratio) per building envelope and façade orientation (Figure 2.1.4). Furthermore, these scripts perform an initial calculation of building elements and material quantities. Holistic models are thus finalized to fulfil a broad range of regenerative design targets, by using existing scripts and tools for types of simulations and integrating them in the parametric design workflow.

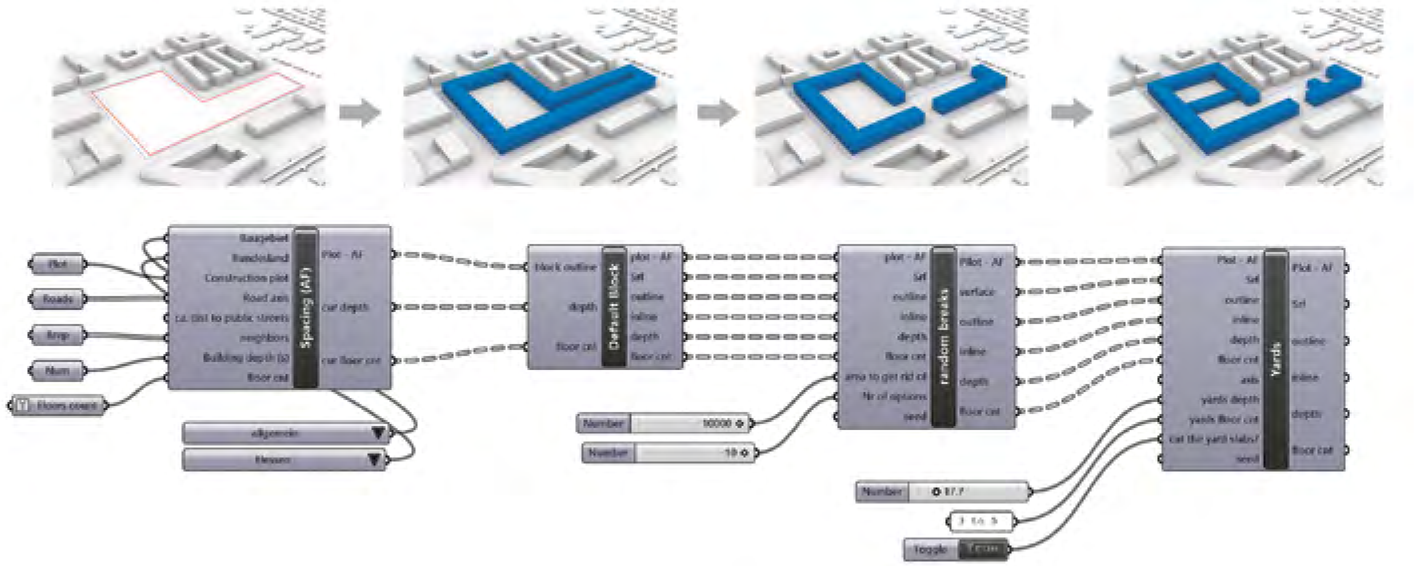

Figure 2.1.4. *A parametric workflow for the generation of building volume alternatives on the basis of site rules and user inputs. (Source: Osintseva et al., 2020).*

Digitally Linked Domains

Parametric design facilitates the creation of sets of relations between scripts and therefore domains. Algorithmic inputs and outputs (*e.g.,* for thermal comfort studies) and data generated by the process are used in a large number of simulation and calculation tools available with Grasshopper (*e.g.,* those concerned with water flooding and with biophilia).

Some perform operations and calculations inside Grasshopper using existing models developed by researchers, such as the Universal Thermal Climate Index (UTCI) (Bröde *et al.*, 2010) for outdoor comfort evaluations (i.e., components of Ladybug Tools). Others connect specialized components available for inclusion in the parametric model with externally validated software such as EnergyPlus (National Renewable Energy Laboratory, 2020) and OpenFOAM (OpenCFD, 2020), *e.g.,* tools available in ClimateStudio (Solemma, 2020) and Eddy3D (Kastner and Dogan, 2018).

The inclusion of tools and components in the same parametric model gives designers and planners the option to develop scripts that interlink with other domains, such as indoor and outdoor environments (Figure 2.1.5). This potential is crucial for developing complex parametric models that obtain multi-level design solutions, beyond the simple concept of sustainability that is related to single discrete targets.

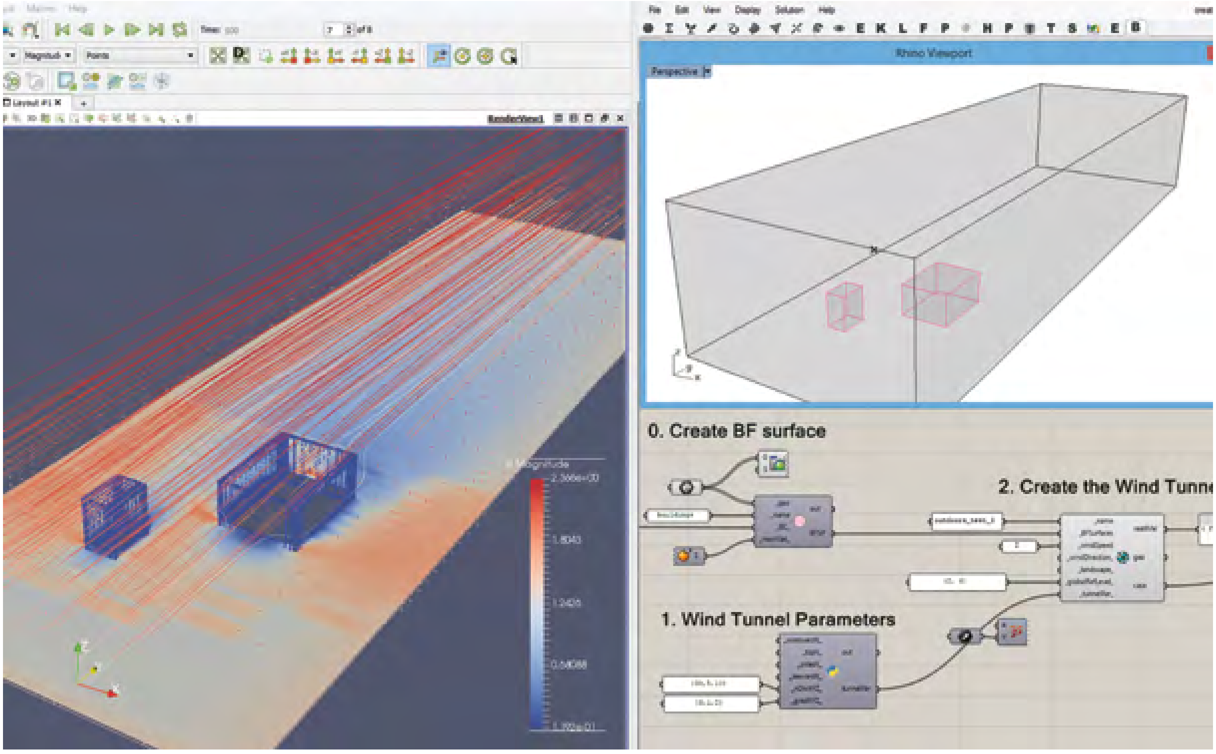

Figure 2.1.5. *Integration of a parametric model and CFD simulations performed in OpenFOAM through the Grasshopper plug-in Butterfly.* *(Source: Ladybug Tools).*

Digital Scale Jumping

In recent years, digital tools that relate scales for climate, energy, indoor and outdoor comfort modelling at the district and city level have seen significant development. Nevertheless, these tools are not yet fully interconnected and integrated with digital tools for the same performance analysis at the building and block scale. Parametric design workflows can be used to connect the scales of the project in three ways:

> Scripts are predominantly used to generate single buildings and clusters at the block and district scale. The parametric models create massing variations of the single buildings or layout alternatives of some buildings. These variable geometric models are inserted inside larger static geometric models of the entire portion of cities for climatic analysis and simulations.

> The same parametric model that generates single or clustered buildings are connected with tools, such as Urbano (Dogan *et al.*, 2020) and DeCodingSpaces (Reinhard, Bielik and Schneider, 2018), that create and analyze urban networks for vehicular and pedestrian movements, functional connections and amenity locations.

> The parametric model can be of larger areas and entire cities via software tools such as Urban Weather Generator (Bueno *et al.*, 2013) for the Urban Heat Island effect modelling. The latter is available as a plug-in within the Dragonfly suite (it is part of Ladybug Tools) (Figure 2.1.6).

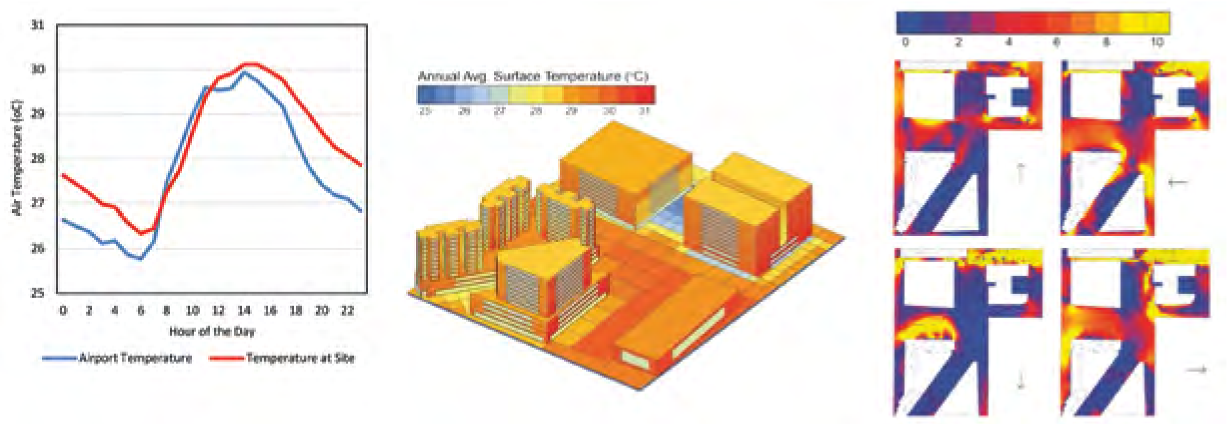

Figure 2.1.6. *Workflow realized through parametric design integrating climatic analysis and simulations such as urban weather, surface temperature and wind analysis. (Source: Christopher Mackey).*

Understanding Conflicting Objectives

In building design, one of the main functions of designers is to provide occupant indoor comfort and low energy consumption. Daylight represents one of the significant aspects for indoor comfort, in so far as it facilitates the performance of tasks, increases the architectural quality of interiors and improves both psychological and physiological well-being among occupants. Additionally, it has been proven that daylight increases worker productivity and student learning capacity. On the other hand, an excess of sunlight and daylight can cause occupant discomfort due to glare effects.

Performance targets are, in many cases, conflicting. For example, a narrow urban fabric (high density) protects pedestrians from direct radiation during the hot season. At the same time it decreases visual comfort in interiors. When buildings are disperse (low density), when sunlight penetrates streets, a pattern of buildings provides pedestrian comfort during colder seasons and causes discomfort in the warmer season (as a consequence of direct radiation that is not blocked). In both cases, the task of ensuring thermo-visual comfort is complex due to conflict between the existing performance objectives.

It can also increase consumption of heating energy within the building in winter, due to increased fenestration, that implies less thermal insulation than walls, or decreased heating energy due to solar gains. It can likewise cause more abrupt increases in cooling energy consumption, due to large amounts of solar gains in summer. This example also presents the interrelation of multiple and often conflicting objectives.

Parametric tools offer the possibility of exploring design strategies that are negotiating targets. They can be implemented through the performance analysis of the objectives to find optimal solutions or best trade-offs, or by using selected results of one or more objectives as the parameters to develop the design process, as explained below.

Multi-domain and Optimization of Objectives

Optimization tools such as Galapagos, Octopus and Opossum (Wortmann, 2017) can be integrated into the design workflow of Grasshopper to incorporate urban design parameters, environmental factors, simulations and metrics requirements with a single objective and multi-objective optimization algorithms. Single objective optimizations concern simple tasks such as finding the minimum size of a window located on a specific façade of a building, in an urban environment and climate, for the fulfilment of an exact daylight target (Figure 2.1.7).

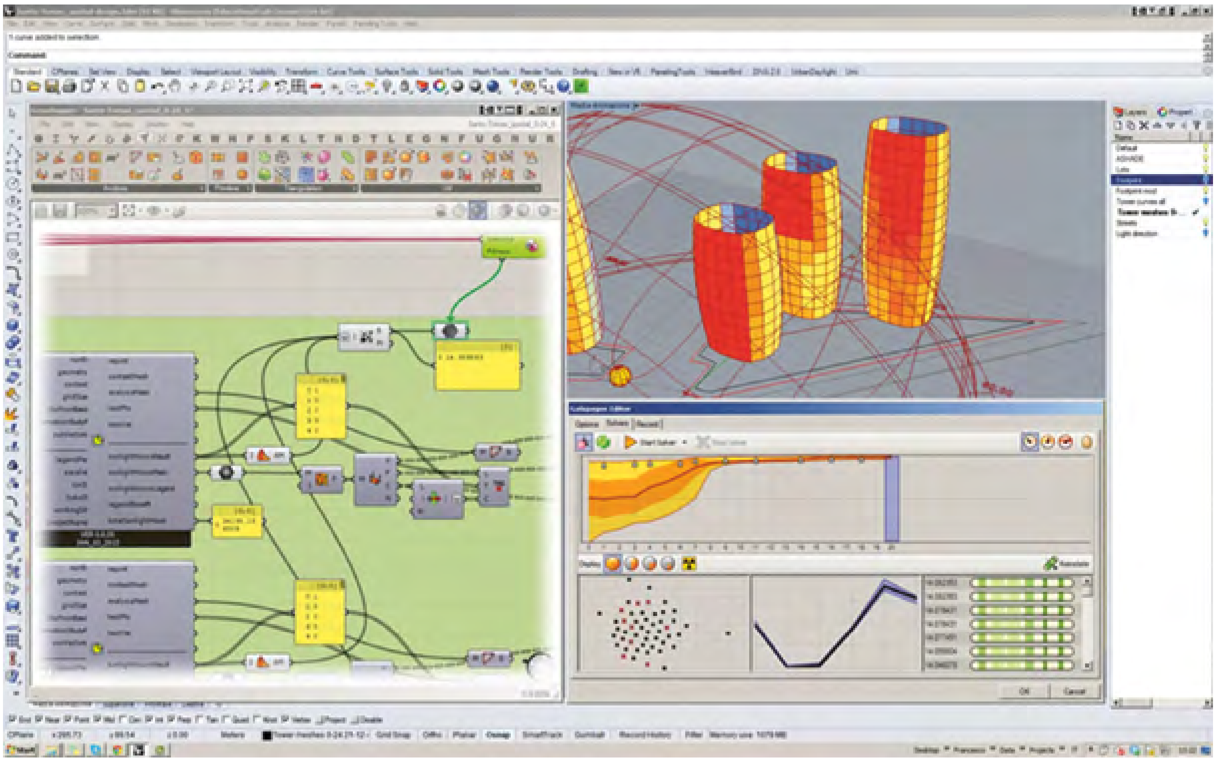

Figure 2.1.7. *Layout optimization of residential tower buildings for maximization of sunlight access.* *(Source: Authors).*

Multi-objective optimization is particularly indicated when conflicting objectives need to be taken into account, as described above. Continuing with the example of the window optimized for daylight, multi-objective optimization is used to find optimal solutions that balance daylight provision and whole-building energy consumption. Also, multi-objective optimization can find optimal design solutions not only taking into account conflicting objectives of the same domain, but also, and perhaps more interestingly, objectives of disciplines, *e.g., the* outdoor and indoor performance of building clusters, and other aspects of building design, *e.g.,* the relation between the structure of buildings and the envelope, including potential daylight provision.

The optimization tools are seamlessly integrated into the parametric design workflow through the use of the project parameters as genomes. Iterations (generations) will then be performed to select the fittest parameters and consequently, the best performing solution in the single-objective optimization. In the case of multi-objective optimization rather than a single best solution, there is a group of "best" solutions (Pareto front) from among which the most appropriate can be selected based on specific design criteria.

Addressing Multi-domain Integration Through Machine Learning

Machine Learning tools and workflows for real-time decision making and interactive participation can be used in the design workflow from the neighbourhood to the city scale for real-time and interactive decisions and generation of data to use in stages/blocks of the design process. In recent years, Grasshopper plug-ins have included the potential advantages of Machine Learning in the parametric design workflow. Owl, Dodo and Lunchbox are recent examples (Miller, 2020). The Machine Learning methods that these tools use most are unsupervised learning and supervised learning (Tamke, Nicholas, Zwierzycki, 2018). The significant potential of Machine Learning is to substitute the simulation processes through system training.

The parameters of the parametric model and the results of a limited number of simulations are used for training the system. Results that are very close to the simulation outputs can be obtained with Machine Learning for every type of simulation, within concise time-frames, even a few seconds, unlike simulations than can take several hours. Machine Learning is, therefore advisable when using the parametric models integrated into Grasshopper for regenerative design. For example, when climatic factors such as solar radiation, temperature and wind, and their effects on building energy and surface temperatures are considered for the assessment of outdoor comfort. Keeping in hand the option of performing such evaluations in real-time through Machine Learning, designers and planners can increase the interactions of parameters and performances in the parametric model, enabling them to design projects with considerably greater regenerative potential.

4 Conclusions

In this chapter, a map has been drafted of the tools that are available to designers and planners for the incorporation of regenerative system thinking into their work and when defining the regenerative city principles. Furthermore, it has introduced the potential strengths of parametric tools, primarily available to the design and planning community, for the creation of workflows at early stages of the design phase when regenerative targets can be introduced and performance can be improved at scales and at other project dimensions.

Digital tools have the scope to evaluate changes in performance for multiple regenerative benefits of design solutions and trade-offs. These tools are available to designers and planners and can be integrated into holistic workflows. They allow maximizing the positive performance of ecosystem services, both indoors and outdoors. The power of linking multi-domain and dimensional tools is an integral part of a digital parametric environment offering high flexibility and adaptability to connect multiple domains and scales to face a large volume of data related to ecological and human health issues.

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2.2

Smart Technologies in the Context of Regenerative Design - IoT, (Big) Data, AI, Digital Twin

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TABLE OF CONTENTS

Summary

In this chapter, the conditions, the smart policies, and the technologies that can boost the process of a paradigm shift towards restorative sustainability are mapped out. In Section 1, the definition of smart cities will be introduced within the context of regenerative design and planning. The focus of Section 2 will be on new peer-to-peer approaches towards sharing and trading resources within smart cities and the co-design of smart sustainable cities. The role of (Big) Data for smart sustainable city planning and management will be introduced in Sections 3 and 4 together with Digital Twin as a tool for enhancing modelling and simulation capabilities in this context. In the final section, the focus will be on neighbourhood sustainability and (non-geographical) energy islands as power grid stabilizers, and buildings as nodes both in micro- and in nanogrids.

The contents of this chapter are addressed at politicians, city planners, and administrators working for municipalities/cities, at regional and national level, as well as at architects and developers in the private sector. We strongly believe that the introduction of regenerative approaches into the planning of smart cities is a key measure in bringing together all the actors shaping the built environment. These approaches will contribute to enhancing human-nature relations and the sustainability of existing and planned urban structures. A number of topics in the area of smart technologies will be introduced in this chapter, in order to lead the reader through the process of implementing smart policies and solutions based on regenerative approaches. Recommendations will also be provided on how to integrate new, disruptive technologies into the regenerative design of cities.

Addressing Scale Jumping

Scale jumping is going beyond the building to district, city or even regional scale. We no longer implement smart solutions within single buildings, but think of system interoperability and system interconnectivity. Such an approach forms the basis for more holistic assessment, and enables the introduction of new regenerative solutions. There is a clear need to go beyond pilot and trial projects, towards the wide-scale roll out and implementation of smart regenerative solutions.

There is also one more level of scale jumping: moving from an individual scale (personal smart solutions) up to society scale (smart solutions answering societal needs). The sections that follow will describe how smart open platforms can be employed to facilitate restorative sustainability practices at the urban scale. Collaborative technology platforms will be described that enable scale jumping for solving urban issues by empowering residents for cooperation in decentralized ways at a local, district, neighbourhood, city level. New technologies such as Distributed Ledger Technology (DLT), IoT and artificial intelligence will have significant roles to play for the scale jumping of smart technologies.

1 Defining the smart-city in the context of regenerative design and planning

By Dorota KAMROWSKA-ZAŁUSKA, Gerald LEINDECKER, Marielle FERREIRA SILVA, Gulben CALIS, Aleksandar PETROVSKI

1.1 Background

Smartness is becoming one of the dominant doctrines shaping the cities of today. Digitalization and increased connectivity are not only changing the built environment, but they are also influencing the living patterns of city dwellers. New disruptive technologies such as advanced machine learning, access to large amounts of information (Big Data), and real-time data-based adaptive systems of virtual and augmented reality are facilitating smarter cities through the provision of highly efficient usage of both resources and quality urban services. Thus, in the future, increasing interoperability of systems in real-time will promote data-driven policies.

At the same time, many cities all over the world are adopting various smart solutions, but one can only ask if they are all strengthening the sustainability and the resilience of urban built environments (Kamrowska-Załuska, D., Obracht-Prondzyńska, 2018). The rise of consumption and urbanization in its current form threaten the very future of humanity and the natural world. Additionally, considering the growing urban population (WHO predicts global urban population growth of 1.63% per year between 2020 and 2025), the United Nations included sustainable urbanization as one of the major elements in the Sustainable Development Goals (SDG 11: Sustainable Cities and Communities (UN, 2016)). Uncontrolled migration from rural to urban areas can provoke negative effects: public health problems, higher vulnerability to natural disasters, poor infrastructure, proliferation of poor housing conditions, and social instability (ADEC Innovations, 2016).

The need therefore arises for continuous renewal and restoration of the ecosystems that underpin the existence of our urban systems (Du Plessis, 2012). A call for change and recognition of the need to take positive steps towards regenerative cities (Girardet, 2014).

The above-mentioned circumstances evoke important questions for city planning and design in the future:

> What is the relation between the smart and the regenerative paradigms?

> Can smart solutions and infrastructure support the paradigmatic shift toward regenerative sustainability?

> Under which conditions could those solutions strengthen the relation between humans and nature and support the restoration of degraded ecosystems?

The aim of this chapter is to provide a common definition of the smart city and to study the relations between smartness and regenerative design and planning.

1.2 Definitions and principles of a smart city

The notion of the smart city has developed over recent years and one can now find many different although complementary definitions, the most important of which are summarized in Table 2.2.1.

Table 2.2.1. *Definition of smart city.*

DEFINITION OF SMART CITY	SOURCE
"Integration of infrastructures and technology-mediated services, social learning for strengthening human infrastructure, and governance for institutional improvement and citizen engagement."	Nam T., Pardo T.A., (2011). *Conceptualizing Smart City with Dimensions of Technology, People, and Institutions*, Proceedings 12th Annual International Conference on Digital Government Research.
"A Smart City is an integrated system that interacts with human and social capital using ICT-based solutions. It aims to efficiently achieve sustainable development and a high quality of life on the basis of a multistakeholder, municipally based partnership."	ASCIMER, *Smart Cities: Concept & challenges* (2015). EIB, Universidad Politécnica de Madrid
"A city is smart when investments in human and social capital and traditional and modern communication infrastructure fuel sustainable economic growth and a high quality of life, with a wise management of natural resources, through participatory governance."	Caragliu A., del Bo C., Nijkamp P. (2009). *Smart cities in Europe*. 3rd Central European Conference in Regional Science – CERS
"Cities are becoming smart not only in terms of the way we can automate routine functions but in ways that enable us to monitor, understand, analyze and plan the city to improve the efficiency, equity and quality of life for its citizens in real time."	Batty M. *et al*. (2012). *Smart Cities of the future.* UCL Working Paper Series, Paper 188. ISSN 1467-1298
"The idea of Smart Cities is rooted in the creation and connection of human capital, social capital and Information and Communication Technology (ICT) infrastructure in order to generate greater and more sustainable economic development and a better quality of life." "Smart City is a city seeking to address public issues via ICT-based solutions on the basis of a multi-stakeholder, municipally based partnership.'	Manville C. *et al*. (2014). *Mapping Smart Cities in the EU*. European Parliament. Directorate General for Internal Policies. Policy Department A: Economic and Scientific Policy.
"A city well performing in a forward-looking way in economy, people, governance, mobility, environment, and living, built on the smart combination of endowments and activities of self-decisive, independent and aware citizens."	Giffinger R. *et al*. (2007). *Smart cities—Ranking of European medium-sized cities (Report).* Vienna University of Technology (retrieved from http://www.smart-cities.eu/download/smart_cities_ final_report.pdf).
"A city that monitors and integrates conditions of all of its critical infrastructures, including roads, bridges, tunnels, rails, subways, airports, seaports, communications, water, power, even major buildings, can better organize its resources, plan its preventive maintenance activities, and monitor security aspects while maximizing services to its citizens."	Giffinger R. *et al*. (2007). *Smart cities—Ranking of European medium-sized cities (Report).* Vienna University of Technology (retrieved from http://www.smart-cities.eu/download/smart_cities_ final_report.pdf).

"The use of Smart Computing technologies to make the critical infrastructure components and services of a city -which include city administration, education, healthcare, public safety, real estate, transportation, and utilities- more intelligent, interconnected, and efficient."	Washburn, D. *et al*. (2010). *Helping CIOs understand "smart city" initiatives: Defining the smart city, its drivers, and the role of the CIO*. Cambridge, MA: Forrester Research, Inc.
"It is the implementation and deployment of information and communication technology infrastructures to support social and urban growth through improving the economy, citizens' involvement and governmental efficiency."	Hollands, R. (2008). *Will the real smart city please stand up?* City, 12(3), 303–320.
"Safe, secure, environmental and efficient urban centre of the future with advanced infrastructures such as sensors, electronic devices and networks to stimulate sustainable economic growth and a high quality of life."	Caragliu, A., Del Bo, C., & Nijkamp, P. (2009). *Smart cities in Europe*. Vrije Universiteit. Faculty of Economics and Business Administration retrieved from https://ideas. repec.org/p/vua/wpaper/2009–48. html. Hall, P. (2000). Creative cities and economic development. Urban Studies, 37(4), 633–649.
"Smart people are the result of ethnic and social diversity, tolerance, creativity, and engagement."	Ben Letaifa S. (2015). *How to strategize smart cities: Revealing the SMART model*. Journal of Business Research. Jul;68(7):1414–9.
"The smartness of a city refers to its ability to attract human capital and to mobilize this human capital in collaborations between the various (organized and individual) actors through the use of ICT technologies."	Meijer A., Bolívar M.P.R. (2015) *Governing the smart city: A review of the literature on smart urban governance*. Int. Rev. Adm. Sci., 82, 392–408.
"From a narrow angle, the Smart City can be defined as being on the nexus of three technological advances, namely: the internet of things (IoT), cloud computing, and big data."	Edwards L. (2016). *Privacy, security and data protection in smart cities: A critical EU law perspective*. SSRN Electronic Journal, 2(1)

The smart approach places strong emphasis on technology and focuses on digitalization and development of disruptive technologies. At the same time, it is based on interconnectivity and interoperability principles and increasingly efficient use of resources and systems, which can lead to the introduction of circular economy principles. Another increasingly emphasized and vital aspect of smartness is that the city can only become a smart city when it responds to the needs of both its citizens and its visitors. The aim of smart technologies should be to solve societal challenges. In addition, the need for a smart population that participates in public life must never be forgotten, if those challenges are to be addressed, so as to take greater advantage of smart technologies. Therefore, intelligent people must be open to both learning and change, and remain sufficiently flexible and creative to adapt to the built environment and to adapt the built environment to nature.

1.3 Principles of regenerative approach

Restore Cost working group 1 (Brown *et al.*, 2018) introduced the following definition of regenerative design: a system of technologies and strategies, based on an understanding of the inner working of ecosystems that generates designs to regenerate rather than deplete underlying life support systems and resources within socio-ecological wholes.

Girardet (2015) is stressing that to introduce regenerative cites, we need to find ways of initiating:

> environmentally enhancing, restorative relationships between cities and the natural systems that they depend on;
> the mainstreaming of efficient renewable energy systems for human settlements across the world, and;
> new lifestyle choices and economic opportunities that will encourage people to participate in this transformation process.

There are four important aspects which should be taken into consideration during transformation to regenerative cities (Kamrowska-Zaluska, Obracht-Prondzyńska, 2018): (1) creating a positive balance of energy and circular flow of materials; (2) a holistic approach; (3) the full life-cycle circular approach; (4) assessing flows (instead of states).

The introduction of the regenerative city requires holding fast to the following principles: strengthen the human relationship with nature; ensure restoration of degraded ecosystems; and, base our action on deeply ecological approaches. Simultaneously, regenerative development is answering human needs, and solving societal challenges through the circular economy. Rather that assessing impact within individual sectors, regenerative frameworks are based on a holistic approach.

1.4 Links and differences between smart and regenerative approaches

Are smart and regenerative complementary or contradictory approaches? The principles of smart city and the regenerative approach, Figure 2.2.1, identify common aspects of both approaches. They aim at answering human needs, solving societal challenges and increasing efficient use of resources and systems. However, smart approaches focus on improving the level of urban services, public security and safety, while regenerative approaches are beyond implementing green growth, a concept understood by various global companies and governments. It is focused both on strengthening human-nature relations and on the restoration of degraded ecosystems.

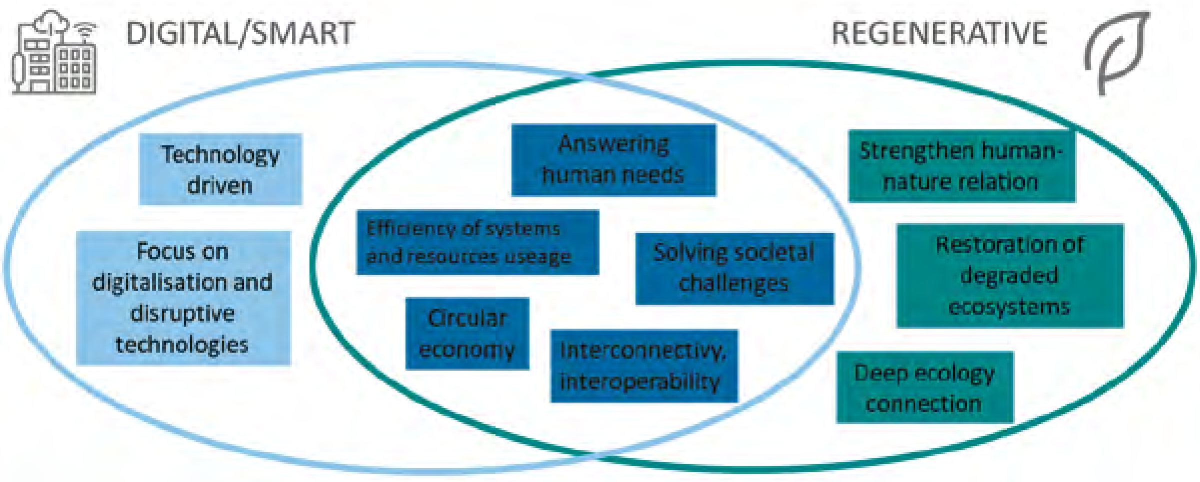


Figure 2.2.1. *Smart and regenerative approaches comparison*

Interconnectivity and interoperability, vital for smart development, can be connected with the integrated approach of regenerative frameworks, which rather than assessing impact in individual sectors, are based on a holistic approach.
The smart approach is also driven by technology and is focused on digitalization and disruptive technologies. We cannot associate the principles of easier access to technology, *e.g.*, an autonomous car, that in the future leads to hypermobility and higher consumption of resources, with the regenerative approach.

1.5 Conclusions

Today's world needs a change of approach in order to shift toward regenerative sustainability. The smartness must be inserted in everyday life, where smart people make decisions and use strategies and technologies to facilitate life and meet societal needs. There is a need to determine how new technologies affect the development of cities and the way they influence ecosystems and the wellbeing of their inhabitants. Nowadays, the smart city is among the most important ideas shaping the development of cites all over the world, however if it is ever to be effective, the proposed solutions must be based on both social and environmental sustainability principles. Moreover, smart solutions need to be integrated within the existing urban networks such as: city infrastructure, innovation milieu and social networks.
It is evident that the creation of regenerative cities will be substantially, if not inevitably, supported by the implementation of smart technologies, artificial intelligence, big data and similar advanced technologies which can integrate the multitude of complex systems, infrastructures and all the prerogatives of a city into a holistic regenerative system.

2 Smart platforms for collaborative urban design and peer-to-peer sharing of resources

By Barry HAYES, Dorota KAMROWSKA-ZALUSKA, Aleksandar PETROVSKI, Clarice BLEIL DE SOUZA and Cristina JIMÉNEZ-PULIDO

2.1 Background and Motivation

This work explores the role of smart platforms in collaborative design and the utilization of urban infrastructures. There is significant potential for leveraging smart technologies, in order to encourage restorative sustainability practices at the city scale through new “sharing economy” concepts and bottom-up, collaborative approaches applied to urban design and resource management.

The move in urban design towards peer-to-peer (P2P) and collaborative approaches is driven by several factors, including:

> *Social and environmental factors:* Increased public awareness of environmental issues, greater public commitment to sustainability practices, and increased levels of engagement with the local community in urban areas.

> *Technological factors:* Increased availability of communications and computing technologies at all levels and scales in cities, massive interconnectivity with vast numbers of intelligent, internet-connected devices (Internet of Things (IoT)), advanced artificial intelligence, and distributed ledger technologies.

These factors are creating new opportunities for individuals and communities to interact with the urban environment via intelligent, connected devices. The aim of this study is to describe how smart open platforms can be employed to facilitate restorative sustainability practices at the urban scale.

The following sections will begin with a discussion of smart technology platforms for collaborative urban design, providing a number of examples of the state of the art in this area. Then, P2P sharing and trading of resources in the energy sector will be discussed in detail; *e.g.*, the potential for smart technology platforms to enable the sharing of new economic approaches. This discussion will illustrate how P2P and co-design approaches and their enabling technologies can optimize the design of city services for their improvement, accelerating efforts towards positive energy districts, local energy markets, and renewable energy communities. Those improvements to energy systems are needed to achieve the goal of Regenerative Sustainability within our cities.

2.2 Smart Platforms for Collaborative Urban Design and Sharing Economy

The introduction of new tools for open collaboration within smart cities is rapidly changing the way that collaborative action is organized (Bason, 2017), stressing the need to move from government-centricity to citizen-centricity. The individual citizen does not only become a contributor to policy but constructs own forms of governance through individual networks (Meijer at al., 2019). Policy formation, implementation and service delivery happens within a network of interdependent actors, which are predominantly autonomous organizations (Rhodes, 1997; Koppenjan and Klijn, 2004). Those networks redefine interactions, power relationships, and patterns of rules that regulate behaviour within the network, reduce transaction costs and influence network performance (Koppenjan and Klijn, 2014)

Multi-stakeholder collaboration is influencing the complex value networks that these stakeholders need to navigate. Inviting users to participate by connecting, and "co-create" indicates a shift from a more closed production, service provision model for innovation to a more open, distributed and modular one (Borghys, 2020). Its exemplification are urban platforms. The digital revolution in contemporary society provides smart technologies and digital platforms that, if based on principles of restorative development, can support the transition towards regenerative buildings, regenerative cities and a regenerative society. Urban platforms have emerged as a vision of the smart city built upon co-creation and a network of social relations, as it sets up intersections between local policy-making, urban activism and digital living (Anttiroiko, 2016). Such platforms can provide strong support and can have a profound impact on ongoing and evolving urban processes, by supporting the sharing economy and stimulating collaboration over urban design processes. As has been stressed in 'European green Deal – Striving to be the first climate-neutral continent', the European Commission roadmap for making the EU's economy sustainable, there is a need for a "comprehensive assessment of the role of [online] platforms, including in the sharing economy" and in that view, the future direction and development of such platforms is of crucial importance (European Commission, 2020).

In recent years, open, P2P "sharing economy" platforms, such as AirBnB in the hospitality sector and Uber in the transport sector, have experienced massive growth. Advocates claim that these technologies enable citizen empowerment, improvements in efficiency, and reduced environmental impact, while critics have argued that the true nature of these platforms is centred on economic self-interest and exploitation, rather than any utopian "sharing economy" ideal. However, if they are owned and governed in a fair and democratic manner, these tools can create new possibilities for cooperation in the production and consumption of goods and services (Schor, 2016).

It is noted that digital technologies are the essence of the sharing economy, whereas the sharing economy system is based on efficient, scalable technology, which brings large networks of people together and matches them up to the goods or services they need (Allen, 2017; May et. al., 2017). Sutherland and Hossein Jarrahi (Sutherland & Jarrahi, 2018) defined 'technology' in the sharing economy from the perspective of interactions between human strategies and goals, and in that view they identified a set of six attributes (affordances) that empower stakeholders in terms of organization, hierarchy, transactions, which are: generating flexibility, match-making, extending reach, managing transactions, trust building, and facilitating collectivity.

The review of platforms for collaborative design shows that they can be organized in a decentralized manner, and there are also brave visions for self-governance and bottom-up organization, which move towards a citizen-led future. The use of the living lab method has increased as a way to implement participatory design and to test the solutions that are applied. The differences between them are their approaches both to issues of control, surveillance, and algorithmic management and to the decision-making process over design, stakeholder involvement and task organization. Therefore according to initially established goals, the success of a collaborative design platform is strongly correlated with an underlying decision-making system during the design process and assigning appropriate weight to the voice of different stakeholders.

The collaborative platforms enable scale jumping in solving urban issues by empowering residents to cooperate in a decentralized manner at a local, district, neighbourhood, city level. Recent examples of these platforms include the C3PO participative urban planning platform (C3PO, 2020), and the OpenCities platform (Open Cities, 2020), oriented towards stimulating interaction between residents and local government. There are several H2020 projects involved in supporting collaborative design through urban platforms including the U_CODE project (U CODE, 2020) and Smarticipate (Smarticipate, 2020). These projects and the knowledge they gain from experience can be replicated at an inter-city level (ROCK, 2020).

The enhancement of city planning by co-design and collaborative platforms demands access to different information, and requires visualization of relevant information etc. In that regard such complex platforms integrate a multitude of novel technologies, such as: Big Data analytics, Geographic Information Systems (GIS), Building Information Modelling (BIM), open Application Programming Interface (API), 3D modelling and visualization (3D, Augmented Reality and Virtual Reality), gaming tools, etc. From the literature review (Sarkissian, *et al*. 2012; Broll, *et al*., 2004) it can be concluded that there is a strong public interest in joining in a collaborative urban design with benefits for all of the stakeholders. The sharing of goods has sustainable and regenerative implications, as it reduces carbon footprints and carbon emissions in both household and urban economies (Underwood & Fremstad, 2018).

The theoretical establishment of collaborative platforms for urban design can be based on the concept of the 'smart city', meaning harnessing smart technology to an agenda of sharing and solidarity, (rather) than one of 'competition, enclosure, deepening inequality and division' (Salvia, 2019). If based on those principles, collaborative platforms can support the shift towards regenerative development of the cities. However, one of the key issues for a collaborative platform for urban design that is at once efficient and effective is how the communications, coordination and organizational management is set up, and the establishment of a proper decision-making process in a highly dynamic participatory setting with a pool of urban data.

2.3 Peer-to-Peer Technology Applied in the Energy Sector

In this section, Peer-to-Peer (P2P) technology for energy trading and sharing is described in detail. The aim of this section is to illustrate the potential of smart platforms, using the example of P2P in the energy sector.

Fundamental changes within the energy sector and the power grid are due to three major technology trends: (i) the large-scale integration of distributed renewable energy sources; (ii) the electrification of transport and heating; and, (iii) the extension of communications and control technology to the individual user level via smart metering and building energy management systems (Hayes, et al., 2020)

Power systems worldwide are rapidly divesting from conventional, centralized, carbon-intensive generating plant and are dealing with the large-scale integration of highly-dispersed renewable generation. As we move further towards grid parity from renewable generation and microgrid technologies, a system dominated by zero-marginal-cost energy sources, many have argued that the existing centralized electricity system is no longer fit for that purpose, and that radically new electricity markets designs will be required (Parag & Sovacool, 2016).

There has been significant recent interest in the energy sector in "energy communities" and "peer-to-peer" electricity trading and sharing (Bukovszki, *et al*., 2020). It has also been thanks to the European Community that has boosted the promotion of further decarbonization of the energy system, as a critical aspect to reach the climate objectives set by European Union (European Commission, 2019). In contrast to traditional, top-down energy systems with "vertical" transactions between each individual and some upstream grid entity, these new systems enable "horizontal" or peer-to-peer energy transactions to take place between citizens in the same community or local area. Some have described this as applying an "Uber" or "AirBnB" sharing economy model in the energy sector (Sousa, et al., 2019).

Conventional electricity markets are oligopolies, with large economies of scale. In contrast, P2P or community energy markets can be seen as an application of the "sharing economy" concept (Zhou, et al., 2020). While Uber is a technology platform that shares under-utilized cars, and AirBnB shares underutilized houses, P2P energy trading enables citizens to share and trade microgeneration and energy demand flexibility with others in their energy community.

In theory, it is possible to trade energy on a P2P basis with electricity buy/sell rates that are more favour-

able for the individual citizen than bulk electricity grid rates. In P2P and community energy markets, the costs of transmission, distribution, and taxes are significantly reduced, and intermediaries such as banks, energy traders and energy supply companies are no longer required. Recent work has investigated possible future decentralized electricity market designs, which differ fundamentally from the traditional centralized electricity market.
The traditional centralized electricity market is depicted in Figure 2.2.3. It is typical of the electricity market arrangements that have been in most developed Western countries for several decades, where liberalized markets have been widely implemented for several decades. The design of this system is top-down, with users in the residential, commercial, and industrial sectors at the bottom as price-takers, purchasing electricity from energy supply companies, or retailers: The retailers then interact with a number of entities, in order to trade in a centralized pool market, interacting traders, market operators, generation companies and network operators.

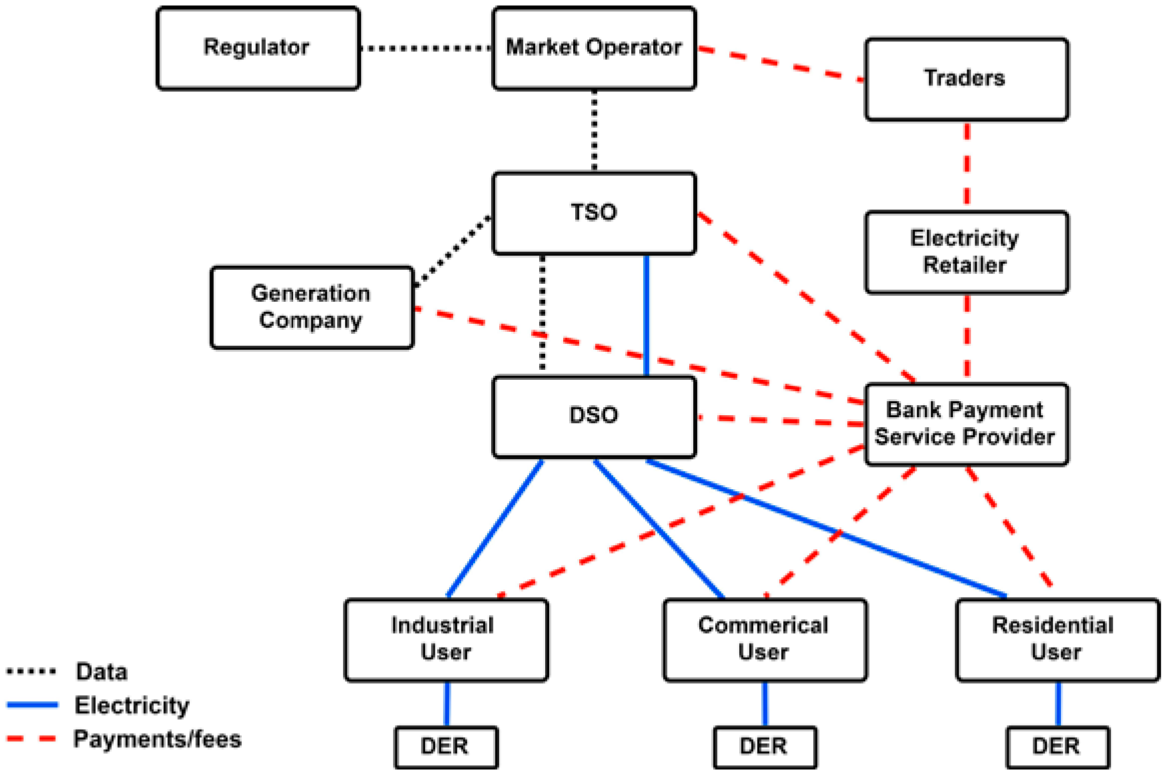
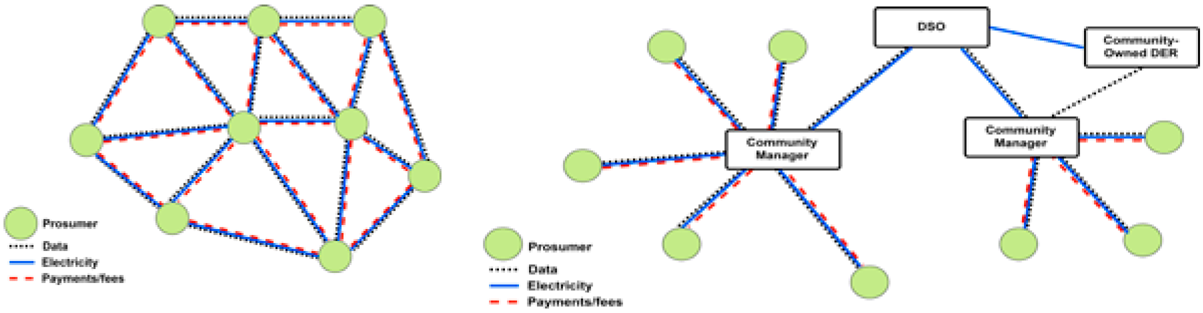


Figure 2.2.3. *Centralized electricity market design typical in most developed countries (TSO = Transmission System Operator, DSO = Distribution System Operator, DER = Distributed Energy Resources).*

While this centralized electricity market model has served well in most developed countries to date, it presents a number of issues, which some would argue, make it fundamentally incompatible with the future vision of a sustainable, net zero-emissions energy system. The centralized model is problematic in an electricity system, mainly based on renewable energy sources, with thousands or even millions of energy resources distributed throughout the network.
From a control point of view, the centralized model is increasingly suboptimal, because there are technical difficulties associated with receiving and sending vast numbers of heterogeneous control signals to a central point, and because such a system is vulnerable to cyber and/or physical attacks on the central control infrastructure (*e.g.*, single point of failure).

In addition, centralized power systems have not over the past few decades been sufficiently successful at providing market access and economic incentives for microgeneration and the participation of active energy citizens. Centralized markets often have minimum entry size requirements, and by their nature are biased towards larger market participants. An attitude that has led many researchers to investigate the potential of future electricity grids and markets with decentralized, "consumer-centric" architectures.

Future grids may have "horizontal" transactions (*e.g.*, P2P or local community markets) either in place of or in addition to the traditional, "vertical" transactions shown in Figure 2.2.2 above (*e.g.*, price signals to the end user from an upstream grid entity). These have the potential to remove many of the intermediaries in the centralized model, by providing a means for individuals and communities to share and trade energy directly with each other, and to provide much stronger incentives for individuals and communities to install renewable microgeneration and microgrid technologies.



(a) (b)

Figure 2.2.4. *Decentralized "prosumer" electricity market designs: (a) "full P2P" market; (b) local community-based market structure.*

Such decentralized market architectures can assume the form of a "full P2P" design where each peer in the network is capable of directly trading with any other peer, or may have a more structured "community-based" design, where each local area has a community manager that manages transactions within the local community, and interactions with the rest of the electricity system, as shown in Figure 2.2.28. It is central to the concept of the "prosumer", the active energy citizen who may both produce and consume energy, according to the availability of local renewable energy resources and energy flexibility (Parag & Sovacool, 2016).

2.4 The Role of IoT and Advanced Computing Technologies

Distributed Ledger Technology (DLT) has attracted considerable interest among researchers, energy suppliers, and start-up companies in recent years for new applications in the energy sector (Andoni, et al., 2019). In a future decentralized system, prosumer-based electricity markets, it will be necessary to have a system that can manage and settle transactions from millions of small Distributed Energy Resources (DER). Such a transaction management system should have an open architecture, in order to easily register new market entrants and accommodate emerging DER technologies.

A significant unresolved question concerns what type of data-management system is most appropriate for a decentralized, prosumer-based market, considering not only management but also resilience and security. Distributed Ledger Technology (DLT) such as blockchain may provide an appropriate solution which meets these criteria, because these ledger systems are inherently decentralized, and are designed to handle large numbers of automated smart contracts securely. It is possible to envisage a future scenario with multiple interconnected local electricity markets, each with fully-decentralized control and no central authority (*i.e.*, a trustless system), with all market participants making decisions on a consensus basis using DLT. However, it is unclear where, in such a system, the responsibility for maintaining security and quality of supply lies, and how the risk associated with reliability issues could be distributed throughout the supply chain.

Another possible scenario is local electricity markets, managed using a traditional, centralized database. DLT may not be required in the implementation of local electricity markets, particularly if it is assumed that the network operator is already trusted by market participants. If network operators are permitted by future national electricity regulations, it is expected that the most beneficial solution in the medium- to long-term will lie somewhere between these two extreme scenarios of fully-decentralized management and control (*e.g.*, full P2P markets implemented using public blockchains) and fully-centralized management and control (similar to the current situation where there is no scope for P2P energy trading and sharing, and local electricity markets).

A "hybrid" scenario may be the optimal future solution where the ultimate responsibility for reliability and security of supply still lies with the traditional network operator, but a significant amount of system supply-demand balancing is distributed via local P2P and community energy markets. Local markets could be used to carry out a significant portion of system supply-demand balancing at the local level, and to provide new means of procuring system flexibility. This arrangement is expected to take advantage of the potential offered by decentralized electricity markets (creating new opportunities for DER participation, increasing renewable hosting capacity, reducing technical losses, deferring network infrastructure upgrades), while keeping the reliability benefits of a centralized "pool" market structure in ensuring security of supply.

It is expected that DLT will have a role to play in the development of new local energy and ancillary service markets (European Commission Directorate-General for Energy (DG ENER), 2020) in managing and securing automated smart contracts using lightweight, permissioned blockchains. Issues around scalability, excessive transaction verification times and high energy consumption can be avoided by carrying out smaller transactions offline and only including aggregated financial transactions in the final ledger.

It is also anticipated that advanced computing techniques, such as machine learning and multi-agent simulation will play significant roles. In its simplest form, the P2P energy market is a collection of multi-bilateral trading agreements between various agents. Recent research has formulated local electricity markets with multiple DER as a distributed optimization problem, which can be solved using iterative techniques (Boyd, et al., 2011). However, there are well-known issues with computational complexity and convergence of these approaches towards very large systems.

It is likely that the multi-agent system approaches will be important in the modelling and simulation of prosumer-based markets, in order to provide tractable solutions that can be scaled up to very large systems as well as to test the resilience of the system. Previous work has demonstrated that multi-agent systems approaches can provide flexible, scalable and fault-tolerant solutions to power engineering problems (González-Briones, *et al.*, 2018).

Other authors have also investigated the possibilities for digital twinning and urban building energy modelling as enabling technologies for prosumer markets and energy communities (Bukovszki, et al., 2020).

2.5 Scale Jumping to District and City Level and Beyond

A number of trial and demonstration projects have been developed to date, which have focused on demonstrating P2P and local community energy markets at the neighbourhood level, *e.g.*, (Mengelkamp, *et al.*,

2018) and (Swiss Federal Office of Energy (SFOE), 2020). Typically, these projects involve energy trading in small, localized areas served under microgrid, or “private wire” arrangements, in order to avoid regulatory problems, such as compliance with national grid codes and electricity market rules.

If these solutions are ever to be implemented on a large scale, it will be necessary to use utility-owned infrastructure for P2P energy exchange and community markets. At the moment, it is very unclear how these solutions can be achieved, and what the potential impacts of decentralized trading platforms and their wider implementation might be on system-level operation and planning (Hayes, et al., 2020). There are significant questions around how responsibility for maintaining security and quality of electrical supply could be managed in a future scenario with P2P and local community markets, and it would be necessary to develop new mechanisms for socializing the costs of maintaining the energy infrastructure (power transmission and distribution networks), perhaps through a re-design of policy and regulation on “use of network” charges.

A major gap in current research into P2P energy and energy communities is the development of solutions that are capable of integrating into existing grid operational practices and into centralized “pool” electricity markets, enabling local and P2P energy trading platforms to scale up to the district, city, and regional level. As discussed above, new technologies such as DLT, IoT and artificial intelligence will have a significant role to play in this scale jumping.

2.6 Cooperative Models and Co-Design Approaches for Urban Energy Infrastructure

So far, this discussion has been focused on the possibilities for P2P markets and local energy communities to help us move towards a more decentralized, flexible, and sustainable approach to energy management at the urban scale. The potential benefits include:

1. Empowerment of individuals and communities to share and to trade locally-generated renewable energy;
2. Reduced energy losses resulting from shorter electricity transmission distances;
3. System-wide benefits resulting from balancing electricity demand and generation at a more local level (increased renewables hosting capacity and reduced need for energy flexibility services);
4. Environmental benefits resulting from the deferral of the need to build new power network infrastructure, reducing reliance on centralized generation.
5. Potential to enable a more resilient (and independent) energy supply.

New technologies such as DLT that can electronically trace supply chains all the way from source to consumption may also influence the future development of other utilities such as gas, water and waste. Some have envisaged a future with “citizen utilities”, a new utility model based on economic localism and on the democratization of ownership and governance (Green & Newman, 2017).

In the energy sectors of many developed countries, community ownership of renewable generation is already well-established, and there is growing trend towards community-owned energy storage. In a future prosumer-based energy system, these co-ownership models may become much more commonplace. Co-ownership may be extended to a much wider range of microgrid and physical network assets, including power distribution lines and cables, as community energy models become more economically viable and socially accepted as a means to achieve greater levels of energy independence and sustainability.

This raises questions on the design of urban infrastructure in an energy system based almost entirely on distributed, renewable energy sources. It also raises questions in relation to how adaptable the existing building stock and urban fabric are for these changes to be accommodated. It presents challenges to the

present model where energy infrastructure such as transmission and distribution networks are considered natural monopolies from a regulatory perspective, and fully owned and managed by network operators.
Future urban energy systems may benefit from a "bottom-up" co-design model, where citizens have a central role in the planning and ownership of energy infrastructures, and where the grid infrastructure is viewed as a common, shared asset, rather than owned by the network operators.

2.7 Conclusions

There are a number of motives behind the recent developments in collaborative "sharing economy" concepts applied in districts and cities. These developments have been driven by new technological advances, but also by social and political changes and increased environmental awareness. In this brief study, the state of the art in smart technology platforms for collaborative urban design has been discussed, providing a number of recent examples in Europe. It has been highlighted that collaborative platforms for urban design present a highly dynamic participatory setting, with very large volumes of urban data. A key issue for the effectiveness of such technology platforms is the design of the communication, coordination and organizational management.
The example of P2P approaches applied in the energy sector is then used to illustrate how sharing economy concepts and their enabling technologies can accelerate efforts towards more sustainable and regenerative urban environments. It has been shown that P2P energy trading and local energy communities can provide strong incentives for citizens to trade by sharing locally-generated renewable energy, and to achieve greater energy independence. New peer-to-peer technologies for economic activity can be powerful tools for change, and are having a significant influence on the development of zero- and positive-energy districts. The approaches may also have a profound influence on the future development of other utilities such as gas, water and waste.
These concepts and the smart technology platforms associated with them are closely linked to the restorative sustainability concepts proposed in the RESTORE project, and can be harnessed to implement positive changes within the built environment. In this section, the role of smart technologies has been discussed, including IoT, DLT, and machine learning in enabling these concepts to be applied within the context of the energy sector. To date, the P2P and local energy community concepts have only been demonstrated at the building and neighbourhood scales and there are significant technical and regulatory barriers to their wider implementation. Scaling these technologies up to the district and/or city scale and beyond can provide significant positive environmental and societal impacts, however, achieving this potential will require radical new approaches to the ownership and governance of urban infrastructure.

3 Role of (Big) Data in planning and management of smart sustainable cities

By Hanna OBRACHT-PRONDZYNSKA

3.1 Introduction

There are many theoretical frameworks introducing schemes for efficient smart urban-data management, as well as many previously implemented urban-data platforms worldwide (Marsal-Llacuna, Colomer-Llinàs and Meléndez-Frigola, 2015; Panagiotou *et al.*, 2016). At the same time global companies offer smart-solution packages for cities (Rathore *et al.*, 2018). Even though many potential smart governance tools have been recognized and implemented, a lot of work still needs to be undertaken to use such tools successfully for designing smart solutions for cities (Babar and Arif, 2017; Babar *et al.*, 2019). Acting within the process brings the question of how can we shift existing urban innovations based on technological solutions, so the cities can benefit from them as they attempt to implement regenerative approaches within the planning process?

Dell estimates that a city of 1 million produces about 30 million GB per day (Dell, 2014). As many disciplines benefit from Big Data analysis, so too can regenerative planning use such opportunities. Surely, smart urban-data management can be a base and a starting point for the transition. Similarly, data-based solutions can be supportive for the introduction of such an approach and smart governance can enhance the transition from traditional to regenerative planning (Kamrowska-Zaluska and Obracht-Prondzyńska, 2018).

3.2 Challenges

With such assumptions there is a need to provide a mechanism that enables the introduction of regenerative approaches within the city planning process. Thus, smart governance should focus on supporting the shift allowing the implementation of urban projects that restore positive balances. Such a transition however entails serious questions:

> How can smart governance enhance a regenerative approach?
> How and when can regenerative planning benefit from smart urban-data management?
> When will it be possible to implement regenerative oriented projects on the basis of smart solutions?

The following aims arose when working to answer the above questions:

> The division into two groups of case study research to collect good practice on data management that can enhance regenerative planning:
  - open data city platforms sharing relevant data for the regenerative approach,
  - projects contributing to the process on implementing regenerative approach,
> Recommendations on the type of data that cities can collect and collection methods.

So far, the cities have experience with the successful implementation of smart governance supported by smart strategies and policies. Basic tools, such as integrated platforms, have been delivered and many smart solutions have been implemented together with smart innovations, showing how such an approach can lead to engaged smart societies (Yigitcanlar, 2015; Gharaibeh *et al.*, 2017). The next step can be taken by using tools to lay the groundwork for the next step in the planning process. It nevertheless calls for a much-needed evaluation of the practical aspects of urban-data management.

3.3 Lesson learnt from smart urban-data management

Smart governance

The tools for successful smart governance are data-based policies, strategies and urban-data management. The challenge is to apply smart solution-based documents as an added value to existing policies, which are not fully integrated with planning decisions. It may however mean that some data-sharing platforms are not fully recognized. Furthermore, any knowledge will not be used for the implementation of data-based solutions, as the platforms are only used for storage.,

Data-sharing platforms

Data collection is usually integrated, but the function of data-sharing platforms is despite their ambitions still limited. As most of the existing solutions only focus on data collection, the opportunity of real-time monitoring is not used. The remaining challenge is the contribution from the private sector. Unfortunately, we have so far only managed to integrate administrative data and data collected with locally implemented solutions. Companies, on the other hand, are still excluded from the data-collection process. Data-sharing platforms are focused on administrative data and local private sectors while global companies can provide most of the knowledge on societies.

Data collection and sharing

Most platforms share a lot of urban data collected within the cities. Administrative databases can certainly be supportive for many other analyses. However, most databases only provide open access to basic information, which are not systematically updated. The gap appears in the form of randomly shared datasets and missing metadata, so real-time monitoring still remains a challenge without systematic solutions.

Real-time monitoring

As data collection is sector by sector, so too are the analyses that have been conducted. Regenerative planning however calls for a more integrated and holistic approach. Real-time monitoring only yields partial results with the solutions that are implemented for change.

Data based analysis and education

We use data to understand urban processes however we do not share the results with those who contribute to our platforms. We need to enrich data collection with well-established communication tools, so that society remains committed not only to the delivery of data but also to urban transition.

Smart solution-based projects

Well organized urban-data management certainly supports smart solutions, but offers no help for their integration. The challenge is the scale of requirements to provide integrated solutions offering holistic approaches to solutions for urban issues. Despite existing offers of packages for smart urban solutions, most of them are only partially implemented, which shows that we are in the middle of the process.

3.4 Recommendations for data urban management supporting regenerative approach

Such diagnosis leads to the recommendations for organizing the urban-data management aiming to enhance the implementation of regenerative planning. There are five integrated actions needed to make the transition successful and to embed the regenerative approach within the urban-data management process, which are as follows:

Integrate & systematize

As the regenerative approach calls for holistic solutions there is a need to establish platforms for urban-data management that offer not only data integration, but also integrated solutions for data processing that will further contribute to smart planning decisions. The shift from a sectoral to a coherent approach for data collection is necessary. To do so, establishing **urban-data cooperation** can be used a supportive solution that can integrate all the actors contributing to the transition of the approach. While **multilevel and multisectoral cooperation** for **data exchange** is established, the transition process is enabled.
Data need to be constantly up to dated, otherwise the **real-time monitoring** and **real-time urban responses** fail at the beginning of the process. The m**echanism for systematic data collection** needs to be designed and integrated in the process of implementing the regenerative approach. At the same time both the urban-data platform and urban-data cooperation need to adjust as the process brings the change.

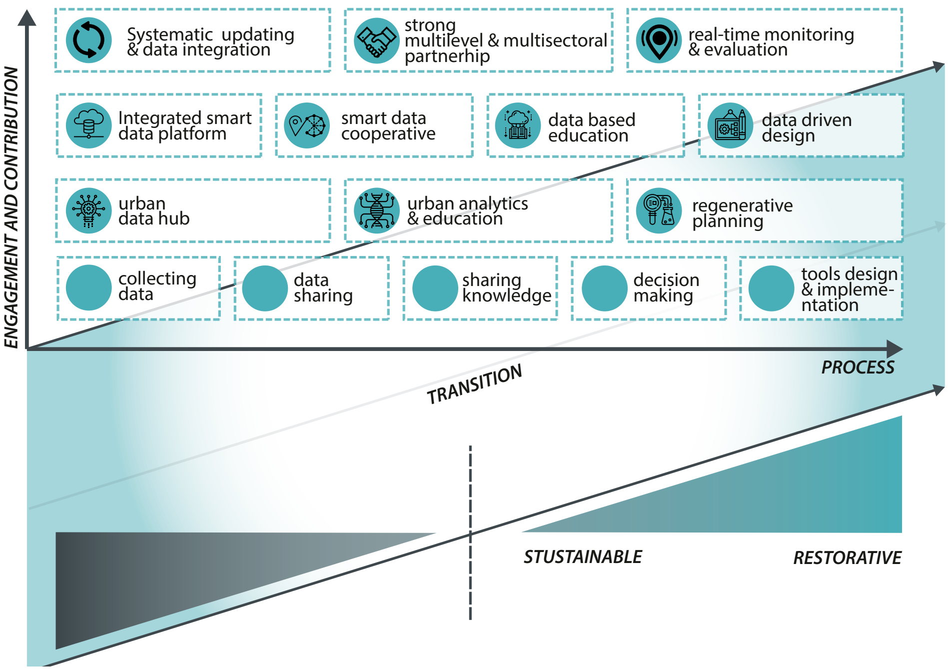


Figure 2.2.5. *Smart urban-data management and smart governance for regenerative planning.*

Monitor, explore & investigate

The monitoring process should be organized in such a way, that both **contributors and stakeholders are engaged in the process** of understanding the transition of approaches. The platform is not the end of the process. Data hub brings analytics not only for data processing but also for building social awareness.

Perform

Implement solutions as a result of analysis being a part of smart urban-data management.

Share & engage

Sharing and exchange of data and knowledge with an open policy can advance the process of implementing a regenerative approach. **Social engagement** is recognized as crucial for such processes, as the residents can make the change themselves by contributing to the data-collection systems.

Repeat & evolve

In the transition process, new tools on each phase will be needed for the circular approach to data-based projects to be supportive. While the shift towards a positive balance is recognized as the main aim of the regenerative approach, not only is real-time analysis needed but also tools for enabling such processes.

4 Digital Twin: Enhanced simulation for smart cities

By Antonino MARVUGLIA

4.1 Introduction

Originally developed to improve the performance of manufacturing (industrial) processes, the concept of Digital Twin (DT) has recently been reassessed as a digital replica of living and non-living entities that enable seamless data transmission between the physical world and the virtual world. As a consequence, the DT is an increasingly explored tool used to improve the performance of physical entities, hinging on computational techniques, themselves enabled through a virtual counterpart (Jones *et al*., 2020).
A consolidated and consistent definition and view of the concept of the DT is however missing from the literature (Barricelli, Casiraghi & Fogli, 2019). This has led to several definitions of DTs and the digital twinning process that engenders the risk of making the concept fuzzy and reducing the advantages that were originally supposed to be linked with DT when the concept was conceived.
Through an extensive literature review, (Jones *et al*., 2020) identified a list of 19 themes that both describe and characterize a DT and its practical implementation:
1. Physical Entity; 2. Virtual Entity; 3. Physical Environment; 4. Virtual Environment; 5. Fidelity; 6. State; 7. Parameters; 8. Physical-to-Virtual Connection; 9. Virtual-to-Physical Connection; 10. Twinning and Twinning Rate; 11. Physical Processes; 12. Virtual Processes; 13. Perceived Benefits; 14. Digital Twin throughout the Product Life-Cycle; 15. Use-Cases; 16. Technical Implementations; 17. Levels of Fidelity; 18. Data Ownership; 19. Integration between Virtual Entities.
All the descriptions of the DT within the literature contain three fundamental elements: a physical product, a virtual representation of it, and a bi-directional data connection that ensures data transfer from the physical to the virtual representation, and the transfer of information and processes from the virtual representation to the physical (Figure 2.2.305). This cycle between the physical and the virtual objects is called mirroring or twinning (Grieves, 2014). Twinning therefore consists of synchronizing the virtual and physical states. In this sense, the state of the physical entity is measured (normally via connected sensors) and the state of the virtual environment is adjusted if necessary, until they are 'equal', *i.e.*, all the parameters have the same values in the virtual entity and the physical entity (*i.e.*, the two entities are 'twinned'). One can then speak of a metrology phase, in which the state of the physical entity is pictured, and an updating phase, in which the discrepancy between the physical and digital entities is determined and the virtual entity is updated accordingly.
This process entails continuous cycles of optimization, because possible physical states are predicted in the virtual environment and optimized to achieve a specific goal. In other words, a virtual optimization process is launched to determine a new, optimal set of virtual parameters, which is then relayed to the physical twin. This latter responds to the change, and its new physical state is once again measured and communicated to the Virtual Twin, which is then updated. The difference between actual and predicted state can then be compared and the optimization process can be run again. The twinning rate is the frequency with which twinning occurs.
Boje *et al*. (2020) collected several concepts on the subject of DT and referred them to the more overarching concept of the Virtual-Data-Physical paradigm. The paper also presented a clear example of a Construction DT (CDT), with the specific aim of facilitating smart construction services. In this particular case, the role of Building Information Modelling (BIM) in the process of data organization and its use in the optimization

process described above was also highlighted. Interestingly enough, the authors proposed a 3-tier level CDT paradigm, which started with the implementation of monitoring platforms (an enhanced version of BIM on construction sites), evolved into intelligent semantic platforms, and culminated in the adoption of advanced forms of Artificial Intelligence (AI) to construct a self-reliant, self-updatable and self-learning DT.

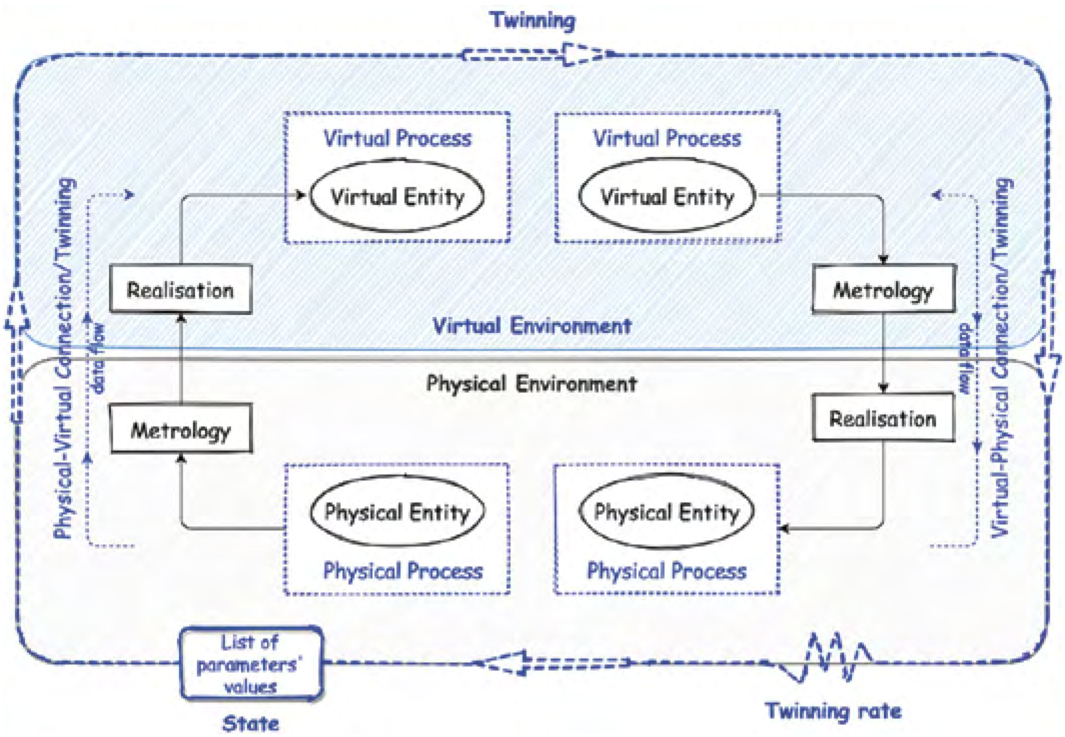


Figure 2.2.6. *Schematic representation of the physical-to-virtual and virtual-to-physical twinning process. Adapted from (Jones et al., 2020).*

4.2 Digital Twins in the context of smart cities

Interest in Digital Twins has grown so much that it was listed by Gartner as a key strategic technology trend in 2019[3]. Moreover, after a start in industrial applications, in particular in the aerospace field (Tuegel *et al*., 2011), the DT is now pervasive within several domains, including urban building and energy modelling where they are investigated as a tool, ultimately for the improvement of city resilience (Lydon *et al*., 2019). They also made their appearance in the context of smart cities (N. Mohammadi & J. E. Taylor, 2017; O'Dwyer *et al*., 2020; Francisco, Mohammadi & Taylor, 2020).

Using High-Performance Computing (HPC) technologies, a team of researchers from different institutions has been developing a DT for Herrenberg, a small city close to Stuttgart (Dembski *et al*., 2020). HPC was used to analyze, integrate and visualize data describing the dynamics of urban operation in order to simulate the complex, dynamic processes that need to be taken into account in urban planning. The prototype was visualized in virtual reality for supporting design and participative and collaborative planning. The urban DT comprises: (1) A 3D model of the built environment; (2) a mathematical street network model; (3) an urban mobility simulation; (4) an air-flow simulation; (5) a pollution simulation using data from a sensor network; (6) empirical quantitative data, namely, pedestrian and cyclist routes; (7) empirical qualitative social data indicating how urban places are perceived; and (8) photographic documentation of these places.

3 https://www.gartner.com/smarterwithgartner/gartner-top-10-strategic-technology-trends-for-2019/

In building the DT of Herrenberg, the team began by using a concept called space syntax, in much the same way as the human skeleton provides a physical support for all of the other systems and functions of the human body, A space syntax produces a basic, 2D outline of physical grids in a city. This outline can be used to perform spatial analysis, such as predicting the likely paths that vehicules or pedestrians might follow. Using a 3D laser scanner, the team also created a 3D visualization of Herrenberg city centre. Visualizations of various data sets can also be integrated in an immersive virtual reality model. The same study has already provided important information for city planners and government in the state of Baden-Württemberg, and via the interaction with the stakeholders, is supposed to further improve to be able to process additional classes of data.

Similar experiments are also in progress in other cities (Table 2.2.2.2.2).

Table 2.2.2. *Some examples of city DTs around the world.*

CITY	LINK TO MATERIAL AND DOCUMENTATION
Amaravati (India)	https://newcities.org/the-big-picture-digital-twins-for-greenfield-smart-cities/
Boston (USA)	https://www.esri.com/about/newsroom/blog/3d-gis-boston-digital-twin/
Cambridge (United Kingdom)	https://www.pbctoday.co.uk/news/bim-news/cambridge-digital-twin/52581/
Dubai (United Arab Emirates)	https://connectedremag.com/das-in-building-wireless/siemens-showcases-test-bed-for-digital-twins-smart-city-infrastructure/
Jaipur (India)	https://accommodationtimes.com/3d-city-jaipur-project/
Kalasatama, Helsinki (Finland)	http://www.kiradigi.fi/en/experiments/ongoing-projects/kalasatama-digital-twins.html; https://www.hel.fi/static/liitteet-2019/Kaupunginkanslia/Helsinki3D_Kalasatama_Digital_Twins.pdf
Pasadena (USA)	https://www.techwire.net/news/automation-data-among-focuses-for-digital-cities-winners.html
Portland (USA)	https://www.governing.com/blogs/bfc/col-digital-twin-maps-guide-changing-city.html
Rennes (France)	http://3d.rennes2030.fr/Rennes2030/
Rotterdam (Netherlands)	https://www.3drotterdam.nl/#/
Singapore	https://www.3ds.com/customer-stories/single/virtual-singapore/
Yingtan (China)	https://www.huawei.com/en/news/2019/11/Huawei-Customers-Win-Awards-SCEWC
Zurich (Switzerland)	(Schrotter & Hürzeler, 2020); https://frs.ethz.ch/research/cyber-physical-systems/digital-twin-enabled-system-resilience.html

4.3 Digital Twins as a tool for regenerative cities

The concept of a Digital Twin (DT) dates back to the beginning of this century, although their implementation has assumed larger and larger scales, mainly due to the advent of the Internet of Things (IoT) and scalable information. Infrastructure owners are beginning to implement digital replicas of their own assets, but only if a federated approach is used for infrastructure digital twins will this revolutionize our cities.

As advocated by Wildfire (Wildfire, 2018), a large set of opportunities for massive scale digital twins certainly unfolds in front of us, which will potentially bring great benefits, such as improved infrastructure maintenance (with the capacity to predict failures and infrastructure disruptions), business transparency and ultimately better and more extensive optioneering and decision-making. In this sense, DTs represent a supportive tool to test and to accelerate the implementation of actions that can provide greater benefits to society. According to Wildfire (2018), the benefits of DTs at the city scale fall into two categories:

1. **Reactive:** The fast feedback and visualizations that DTs offer enhance high-frequency (real-time or near real-time) interventions and improve the day-to-day running of the city;
2. **Predictive:** Modelling based on accurate input data is used to improve longer-term scenario planning to steer optimal investment decisions (where optimality is also evaluated against criteria linked to equitable, regenerative-oriented interventions).

However, strong collaboration between the technology industry and the construction industry is needed for full and proficient use of DTs. Collaboration is key, so that DTs may accompany and facilitate the scale-jumping process that will mean they can be jump scaled to city and territorial scales.

As mentioned above, DTs do and will have high reliance on IoT data, which allow the measurement, monitoring and modelling of all those “tangible” issues such as infrastructures, connectivity, equipment functioning, etc. However, they also take an extra step forwards, in so far as they have the capacity to factor in the “intangible” elements which are nonetheless important in the path towards a regenerative city, such as the sense of place, the connection with nature of city dwellers and their wellbeing within the city. In this sense, the possibility of also monitoring those aspects via the use of social data collected by citizens, for example Herrenberg DT (Dembski *et al.*, 2020), and visualizing them in powerful simulations, will enable both broad public participation and collaboration between stakeholders.

In conclusion, if scientific research, business developments and technological innovation can converge together so that the development and implementation of the DT idea progresses, our society may be guided towards new paths, based on informed decision-making and analysis of all the possible scenarios that may unfold. If properly used, they should advance both the design and the operation of our cities in a way that fosters the principles of regenerative sustainability (Thomson & Newman, 2018).

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Hydroceramics created by Instituto de Arquitectura Avanzada de Cataluña *(Credit: Arquitectura y Empresa, 2020).*

2.3

Emerging Technologies - ICT, Construction, Operation

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Summary

In this chapter, a discussion will be presented of emerging technologies and their application that will move us towards a sustainable approach that is both restorative and regenerative, and aligned with the notion of scale jumping. These technologies are categorized and interrelated within a general framework that includes Information and Communications Technology (ICT), Construction Technologies, Operational Technologies and City Models. Emphasis will then be given to Construction Technologies with examples that include emerging materials and construction technologies. Several examples where Information and Communications Technology (ICT) and Construction technologies have been applied to City Models at an urban scale will then be outlined. Finally, a discussion and the conclusions on the applicability of emerging technologies on a larger scale will be provided, stressing their potential and capability for positive contributions to social, economic and sustainable improvements within contemporary society.

Addressing scale jumping

Scale jumping will be addressed in this chapter by clustering and identifying three main categories of emerging technologies: ICT, Construction and Operational. They all have the potential to contribute towards the development of City Models. At the same time, the interconnections and the supporting layers between each technology are indicated, not only in an attempt to demonstrate the correlations and the interconnections that may be developed, but also to discuss how emerging technologies can influence each other in the context of scale jumping. Thus, ICT technologies are defined as the supporting layer. The construction and the operational technologies are defined in relation to the built environment, are interconnected with ICT, and are directly applied to improve indoor and outdoor spaces. The supporting or built environment technologies can contribute towards the development of City Models where human perspective issues are addressed.

Emerging Technologies

By Odysseas Kontovourkis and Mercedes Del Rio Merino, Paola Villoria Sáez, Rosa Romano, Vesna Grujoska, Todorka Samardzioska and Kiril Gramatikov

1 Introduction

Over the past few years, the construction sector has been characterized by both process and product innovation that has helped to reduce its environmental impact, promoting new models of design and living.
The potential uses of innovative materials and Information and Communications Technology (ICT) systems have contributed to the buildings and the cities that we inhabit and their transformation into dynamic systems, equipped with artificial intelligence, capable of interaction with the environment and users, aiming to reduce energy consumption and to improve the healthiness of both indoor and outdoor spaces.
The biophilic and restorative approach has contributed to the diffusion of technological innovation linked to the use of adaptive systems and components, from a macro to a micro scale (Brown *et al.*, 2018). In fact, the restorative design framework is essential, so that the built environment can increase its capacity to interact with natural elements, in order to influence health, well-being and user quality of life in a positive manner throughout its life cycles.
In this chapter, a discussion is presented of emerging technologies and their applications, which have already started or have the potential to contribute towards both restorative and regenerative approaches that are oriented towards scale jumping. Four main categories have been identified within this framework and are graphically represented in Figure 2.3.1, together with their interconnections. These include ICT, Construction Technologies, Operational Technologies and City Models.

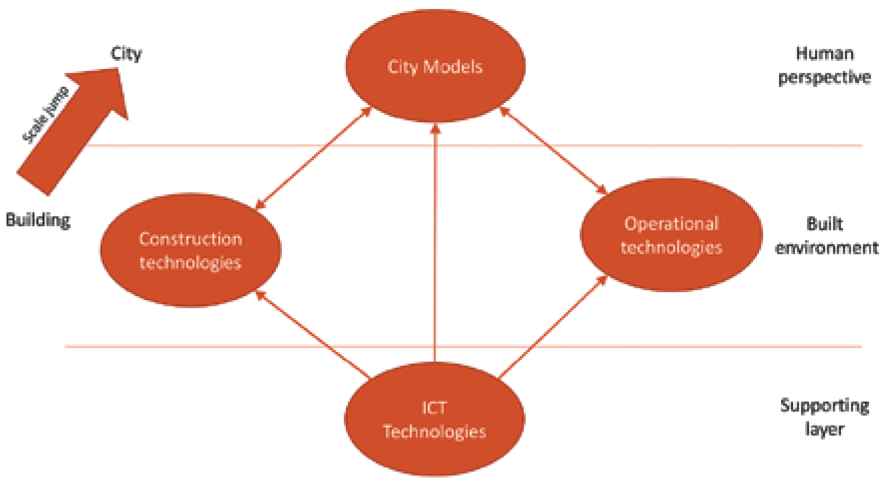

Figure 2.3.1. *Scale jumping of emerging technologies.*

The idea is derived from the need to cluster different technologies, while simultaneously identifying both the interconnections and the support between them. ICT Technologies are defined as the supporting layer, purely driven by Information Technology (IT) principles (ICT, 2020; Grauer, 2001). Technologies related to Construction and Operation are directly used for the built environment; for instance, construction approaches and materials with ICT Technology to support them. The three above-mentioned categories underpin each of the City Models, which demonstrate the potential of each technology, whether built-en-

vironment technology or supporting technology, to move towards scale jumping. Examples of City Models, which can be defined as applications related to investigation and combinations of different technologies, can take different directions. The results are reflected by the variety of city models that can be achieved. From among the examples of Smart Cities, these models rely largely on ICT Technologies, though there are also different combinations and connections between technologies for the built environment and supporting technologies. The interconnections between various technologies can positively contribute towards new city models driven by new restorative approaches.
Also emphasized in Figure 2.3.1 are three additional levels of interpreting emerging technologies within the context of scale jumping. The first one is the role of ICT supporting technology that is at the bottom level of this chart, whereas City Models are at the top, dealing with the human perspective, due to the capacity and the role of a city that provides spaces for human habitation. Interpreting the chart at the middle level, the construction and operational technologies with their contributions to the improvement of both indoor and outdoor built environments, supported by ICT technology, have the potential to be scaled up towards city level.

2 Emerging Technologies

The emerging technologies can be clustered into the following categories:
> ICT Technologies
> Construction technologies
> Operational technologies

The focus of this first sub-section is on Construction technologies, in an effort to provide as much information as possible on the capabilities of these technologies to contribute to restorative and regenerative sustainability. In the second sub-section, examples of City Models are provided where emerging technologies have been implemented with special emphasis on ICT and Construction Technologies.

2.1 Construction Technologies

2.1.1 Emerging Materials

The regenerative principles, as well as the following key aspects of regenerative construction technologies, should be considered in a properly thought through approach to regenerative design:
1. Materials: emerging construction materials (i.e., PCMs, aerogel, metal foam, photocatalytic coatings, etc.) and alternatives to raw materials (i.e., 3D raw materials, biological concrete, etc.).
2. Technologies: automation and robotics opportunities, reduction of waste, energy, cost with a circular approach, etc.
3. Tools: creating a common technical language, helping to define requirements, product performance certifications, etc.

In fact, several interrelated, smart materials and innovative building envelope concepts within the field of regenerative design are now challenging the traditional building paradigm and even today’s standards for sustainable design by expanding the idea of buildings as dynamic and interactive structures.

The new regenerative materials (Villoria Sáez *et al.*, 2019) described in this chapter, which can be used at an urban scale, can be clustered into three main categories: materials designed for higher strength, pollution absorbent materials, self-healing materials and others which improve indoor environmental comfort. Some examples, describing the regenerative materials and the technologies used to manufacture them as well as their main benefits, are shown below:

a. **Higher strength materials:**
   - **Super wood** is a material that when pressed in a certain direction is 30 times stronger than ordinary wood and far more insulative than typical thermal insulating materials. The material is manufactured as follows: first, the wood is boiled in a mixture of sodium sulphite and sodium hydroxide for partial removal of the lignin fibre and hemicellulose; and it is then hot-pressed to crush the cell walls, forming durable nano fibres (University of Maryland, 2018).
     Among its main <u>benefits</u> is its strength; superwood is purportedly stronger than steel yet six times lighter.

b. **Pollution-absorbing materials:**
   - **Pollution-absorbing bricks:** at the centre of these bricks, a cyclonic filtration system separates the heavy particles from the air and collects them in a removable hopper. Its design is very similar to a vacuum and the technology that can be easily applied to current construction processes.
     The main <u>advantage</u> of this material is that air contaminants can be highly reduced. Wind tunnel test results have proved that the system can filter 30% of all fine contaminants.

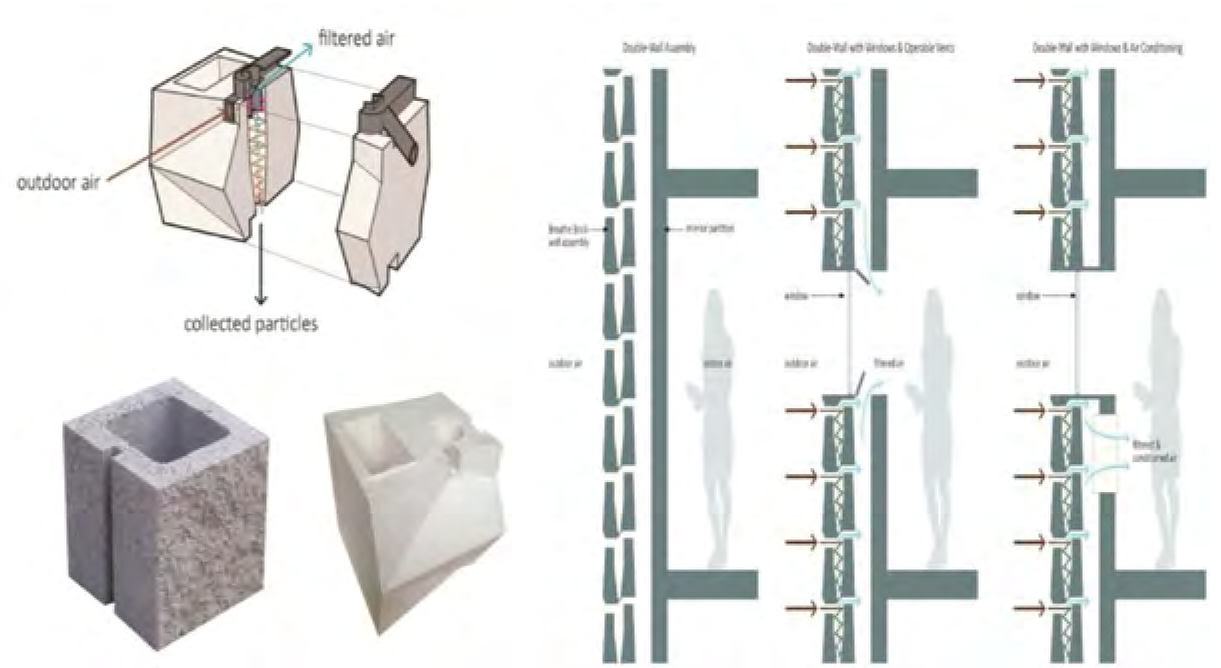

Figure 2.3.2. *Schema of a pollution absorbing brick (Trudell et al. 2015).*

   - **Biological concrete:** This material is presented in a new concept of a "vertical garden". It consists of a three-layer system: the support layer, consisting of conventional Portland cement concrete; the waterproofing layer that protects the support layer from humidity and possible leaks; and the bio-layer consisting of "biological concrete", a magnesium phosphate-rich cement concrete with a sufficiently low pH, between 6.5 and 7, and a relative humidity of around 60%, which makes it apt for the proliferation of (fungal, moss and lichen) microorganisms.

Among the advantages of this new material, we can highlight its contribution to the reduction of pollution, since these types of moss and lichen absorb CO2 and transform it into O2, thus contributing to the improvement of environmental quality. It also absorbs solar radiation, thereby regulating its thermal conductivity and improving the insulation of the building's vertical envelope. (Frias and Manso, 2014; Noguera García, 2013). In addition, this material has relevant advantages over traditional systems that usually require substrates and supporting structures, such as containers for plants and trees, as well as an organic substrate that provides nutrients for vegetative growth. On the contrary, the growth of organisms will be directly on the façade surface of the "biological concrete", which facilitates installation and maintenance and makes it suitable for both new constructions and rehabilitation.

- **Live Bacteria:**
  Bacterial growth within building materials can multiply and create a lower carbon footprint and more sustainable buildings. The researchers began the manufacturing process by inoculating colonies of cyanobacteria in a solution of sand and gelatine. At an ideal setting, the calcium carbonate produced by the microbes mineralizes the gelatine that binds the sand together to form a brick. These durable bricks can actually remove carbon dioxide from the air, rather than pump it out.
  Among the main advantages of the structures built with such materials is that they can heal their own cracks and absorb dangerous atmospheric toxins. Under the right conditions, these green microbes will absorb carbon dioxide gas to help them grow and produce calcium carbonate, the main ingredient of which is a cementitious limestone.

- **Photocatalytic materials:**
  Photocatalysis can neutralize the most common polluting gases in cities, i.e., nitrogen and sulphur oxides, and some other volatile organic compounds. Nitrogen oxides, for example, disappear and as by-products of the process nitrites and nitrates are generated in the form of salts, a slightly heavy powder that is quickly deposited on the ground. Therefore, the main advantage of covering buildings and urban furniture with paints that contain an appropriate catalyst is that it can decrease atmospheric pollution. Relevant examples include titanium dioxide, or the incorporation of catalysts within construction materials such as cement, asphalt, pavements, paving stones, ceramic bricks and waterproof roofing materials, or simply by spraying it over urban installations.

c. **Self-healing materials:**
Self-healing concrete: the use of concrete since ancient times is due to its properties. Its high compressive strength, availability and low component costs were once thought to be everlasting. However, there are also some disadvantages, such as the appearance of micro cracks on the concrete surface as a consequence of its low tensile strength. Water and aggressive agents can penetrate through these micro cracks within the concrete structure that will affect long-term structural durability. Exposure of any reinforcement bars to aggressive agents can cause metallic corrosion and even structural failure, so maintenance and repair of reinforced concrete structures become inevitable over time. However, these processes are time-consuming, expensive and not always easy, especially if access to parts of the structure is limited because of their location or environmental conditions. According to some research, 50% of the annual construction budget in Europe is used for the repair of existing structures (Van Belleghem, Van Tittelboom & De Belie, 2018). Moreover, sustainability is a central focus due to the global ecology. Cement production represents around 7% of total anthropogenic atmospheric CO2 emission (Jonkers *et al*. 2010). Methods that will extend the structural life of concrete structures are therefore a significant area of research.

As a solution to all these problems, scientists worldwide are working on innovative materials that apply the concept of biological self-healing, in much the same way as human tissue heals itself (De Belie *et al*. 2018). Known as self-healing concrete, this material is a regular mixture of cement, water and sand. In addition, the mixture includes some healing bio-agents that can fill micro-fissures and even cracks in the useful life of the structure, so that it repairs itself, with no need for external intervention.

The process of self-healing can be autogenous or autonomous. Autogenous self-healing is also known as natural healing. It is only effective in the presence of micro-fissures and small cracks when water is available. Cracks may heal after some time (Tittelboom and De Belie, 2013), due to ongoing clinker mineral hydration and calcium hydroxide (Ca(OH)2) carbonation.

Autonomous self-healing can be considered as self-healing with the addition of either different agents for self-healing. Healing agents can be biological and chemical (Tagliacozzian *et al*. 2014) and should provide long-term healing throughout the whole lifetime of the construction.

Autonomous self-healing is generally achieved through the use of a bacteria or a capsule based approach. There is evidence that bacterial self-healing is a very effective healing mechanism, which acts through two main pathways:

- Bacteria metabolic conversion of organic acid
- Enzymatic ureolysis (Rajczakowsk, 2019)

This bacterial growth induces the necessary precipitation of calcium carbonate (CaCO3). The identification of suitable bacteria is the result of continuous research. Successful strains of bacteria have to "survive" the environmental conditions within the concrete. In addition to the mechanical action of mixing fresh concrete, the added bacteria have to withstand the high alkalinity environment. They should also be oxygen tolerant (Jonkers, *et al*. 2010). Spore forming bacteria have shown promising signs of life within the concrete matrix and spores activated in the presence of water can remain dormant for over 50 years in the dry state (Jonkers, *et al*. 2011).

In their study, Hendrik Jonkers *et al*. (2010) showed that direct additions of bacteria to the concrete mixture reduced the lifespan of bacterial spores by one-to-two months, due to the hydration process. As a solution, spore protection was investigated through encapsulation or immobilization in protective solutions. This method, known as the bio-mineralization technique, yields promising results for self-healing concrete. Different types of protection have been used in other research work such as expanded perlite (Alazhari *et al*. 2018), expanded clay (Jonkers *et al*. 2011), rubber particles (Xu *et al*. 2018), zeolite (Ansari *et al*. 2020) and hydrogel (Wang *et al*. 2014).

Many other options and novel approaches are tested and investigated in the fast-growing field of self-healing. A variety of materials are currently yielding positive properties when used in concrete structures.

Biological concrete self-healing systems were introduced into the Republic of North Macedonia through the framework of the COST Action: CA15202 –Self-healing as preventive repair of concrete structures – SARCOS, primarily through the activities of the Faculty of Technology and Metallurgy, Ss. Cyril and Methodius University in Skopje working together with the SARCOS RILEM training school (Advanced materials and technologies based on inorganic binders).

PhD students and experienced investigators from 15 different countries participated in the doctoral course and laboratory exercises were performed at the Institute of Earthquake Engineering and Engineering Seismology (IZIIS) of Ss Cyril and Methodius University in Skopje, the Institute for testing materials and the development of new technologies (ZIM "Skopje" AD Skopje) and Cementarnica USJE AD Skopje – TITAN Group.

Some of the course topics were, among others, self-healing materials, modern composites, and sustainability and safety requirements for the use of inorganic materials in construction.

As part of the laboratory practicals, the entire self-healing process was demonstrated and explained, including sample preparation, crack formation, healing efficiency tests and microscopic crack inspections.

Figure 2.3.3. *Laboratory work based on inorganic binders at the Advanced materials and technologies training school* *(Credit: Kiril Gramatikov).*

Self-healing concrete systems applied to real structures are a recent challenge for researchers. These applications have various forms: a spray can be applied to construction materials for the repair of small cracks (0.5-0.8mm wide) and an additive poured into the concrete mix before use. Although presently unavailable on the market, field tests were completed to investigate the use of both methods. Jonkers completed a project in Ecuador to construct a concrete canal and an irrigation system with self-healing concrete. Zhang and Qian (2020) applied microbial self-healing concrete to the sides of a lock channel wall, detecting completely healed cracks after 60 days.

Regarding its disadvantages, this healing technology is at present limited to cracks of a width no larger than 1mm, so it cannot yet be applied to large cracks or pavement pot holes. As its application is still under research and development, there are neither companies that produce the material nor established brands. The cost of this type of concrete can also be prohibitive. The standard price of a cubic meter of concrete is 70 Euros, while the cost of self-healing concrete may be estimated at 100 Euros, according to Jonkers, which is roughly 40% higher.

Among its advantages, self-healing concrete could potentially reduce future production of cement. A central aim of this innovation is to lower the amount of global cement production, which currently accounts for 8% of global carbon emissions. Self-healing concrete could also extend the service life of a concrete structure, thereby reducing both the maintenance and the repair costs of these structures. Nevertheless, as mentioned above, it is limited to healing cracks no larger than 1mm wide in its present form. Research continues into this technology for its further development and commercialization on the market.

d. **Materials to improve indoor environmental comfort:**

We can divide these materials into the following groups: kinetic (i.e., thermal bimetals, shape memory alloys, polymer composites, wood, etc.) and thermal (i.e., Thermal Interface Material (TIM), Phase Change Material (PCM), areogel etc.). In both cases, the material can dynamically contribute to the energy balance of the building, regulating one or more of the following aspects: 1) passive solar gains; 2) direction and intensity of the heat flow and its transfer; 3) direction and intensity of the light flow and its transfer; 4) thermal storage performance; and 5) ability to produce renewable energy (Romano R, 2020).

These materials are usually integrated into living and/or regenerative building envelopes that can be defined as multifunctional highly adaptive systems. The physical separator between the interior and exterior environment can change its functions, features or behavior over time in response to transient performance requirements and boundary conditions, with the aim of improving the overall building performance (Romano *et al*. 2018), protecting people from hazards and helping them access such resources as food, water and shelter (Gambato and Zerbi, 2019).

Over the past few years, several experimental projects have been developed that integrate smart materials and adaptive envelopes into innovative technological solutions. These alternative materials quite clearly have biological systems as their inspiration with morphological forms that recall living organisms. For instance:

- The **SMIT's Solar Ivy thin-film** "photovoltaic leaves", designed to produce energy and shield the indoor space; the Meteorosensitive Architecture prototype developed by Reichert, Menges & Correa (2014), clearly inspired by the morphology and hygroscopic behavior of the strobilus;
- **The Living Glass façade system,** which imitates the behavior of fish gills, thanks to the presence in its transparent surface of parts made of memory material with a CO2-sensitive shape, capable of opening and closing, fostering air exchange inside the building (Geiger, 2010);
- The artistic installation **Articulated Cloud** by N. Kahn for the Children's Museum in Pittsburgh, where a curtain of polymeric elements integrated into the double skin façade moves, imitating the kinematics of a dragonfly's wings (Linn, 2014).
- **Smart windows:** Using this technology, a thin film is deposited on a window pane and flexible versions are under development for easy application to various types of windows (Chen, Lv & Yi, 2012). Building owners and managers could use an app. on their phone to adjust the amount of sunlight that passes through a window during the day, saving on heating and air-conditioning costs.
- The main benefit is that these windows are able to control the amount of light and heat that enters the building and can also be powered by transparent solar cells within the window itself.
- **Hydroceramic bricks:** formed by a combination of clay and hydrogel, the main advantage of this new material is its capability to cool the building interior. These bricks can reduce the interior temperature by up to 6°C, and each brick (due to the water-absorbent hydrogels) can absorb as much as 500 times its weight in water, giving it a considerable cooling effect. The absorbed water is released to reduce the temperature on hot days.

Figure 2.3.4. *Hydroceramics created by Instituto de Arquitectura Avanzada de Cataluña (Credit: Arquitectura y Empresa, 2020).*

Finally, it is important to remember that smart materials and adaptive envelopes within the framework of restorative design should be designed as living organisms, capable of changing their positions and dynamically correcting any structural deformation, reducing their weight and physically reconfiguring their composition in response to user demands over time. The objective should be to create a built environment that is capable of producing positive effects not only for user health, but also for global challenges linked to reducing climate-altering emissions to zero and safeguarding the environment for future generations.

2.1.2 Emerging Construction Technologies

a) 3D Printing

Definition and description

3D Printing (3DP) or Additive Manufacturing (AM) involves the deposition of material layers with various types of mechanized extrusion, controlled with a Computer Numerical Control (CNC), for the production of solidified products. Several 3DP technologies have been developed, among which Fused Deposition Modelling (FDM), Selective Laser Sintering (SLS), Stereolithography (SLA) and Inkjet Powder Printing. The most well-known and widely used technique is FDM, based either on the use of conventional 3D printers or on the application of mounted nozzles on CNC machines that include 6-axis robotic arms and gantries. These technologies can be used for the 3D printing of objects on a small scale, complete structures and building components on a larger scale (Wu, Wang and Wang, 2016; Teizer *et al*., 2016; Kontovourkis and Tryfonos, 2018; Kontovourkis and Tryfonos, 2020; Holt *et al*., 2019).

Figure 2.3.5. *Robotic 3D clay printing (Credit: Kontovourkis and Tryfonos, 2020)*

In the construction industry, 3DP or AM is considered to be an emerging technology (Zuo *et al*., 2019), based on the deposition of different materials ranging from cement to soil-based ones, which are deposited in layers for the construction of large structures, either building components or overall buildings. The transition from a smaller scale to a building scale requires a series of investigations at many levels that are largely related to the effectiveness of each mechanism and the properties of the material in use (Fratello and Rael, 2020). Over past decades, a series of 3DP technologies and materials have been investigated and presented, as well as comprehensive investigations into new applications and demonstrations of their potential within the construction industry, all with promising results. To name a few, such examples include the pioneering work on Contour Crafting (Khoshnevis and Dutton, 1998; Khoshnevis, 2004), on D-shape (D-shape, 2020) and on the CONPrint3D concept for on-site construction (Mechtcherine *et al*., 2019).

Benefits

Despite the incipient adoption and application of 3DP within the construction industry, it is still an emerging technology. It also has outstanding advantages compared to traditional construction methods, which especially include its capability to produce various complex shapes with no need for moulds and to use only the required amount of materials. Other advantages such as the greater potential of using multiple materials, *in situ* resources and both off-site and on-site construction should be mentioned (Camacho *et al*., 2017). As a result of the above, a number of other advantages can added that are directly related to the positive impact of 3DP techniques on environment impacts when compared with modern construction technologies. The application of 3D printing technology within the construction industry will minimize material waste, construction costs and production timelines, while improving accuracy during the construction of complex morphologies. Hence, 3DP can make a positive contribution to the regenerative sustainability of the construction industry (Villoria Sáez *et al*., 2019). The sustainable potential of 3DP technology even extends to social, economic and environmental impacts, which have been examined in several works, either discussed partially or by combining two or more performance indicators (Buswell *et al*., 2005; Weng *et al*., 2020). The following headings refer to some of these benefits: specific measurable indicators such as material waste, environmental impact, construction time, and cost reduction, as well as improvements to constructive precision.

Material waste reduction

The advantages of 3DP with regard to material waste reduction have been extensively discussed in several projects. For instance, the use of formwork in the construction phase of walls and other structures becomes unnecessary, not only bringing zero values to the consumption of materials, but also significant reductions to on-site energy consumption (Weng *et al*., 2020). The application of waste materials to different 3DP processes have also been demonstrated. In one study (Lin *et al*., 2020), a mortar-based waste material in the construction of 3D printing was investigated. Likewise, coordination and optimization of a series of parameters such as time, flowability and material strength were examined in another study (Shahzad *et al*., 2020) on the application of industrial solid waste material in 3DP.

Environmental impact reduction

Recent studies on measuring the environmental impact of 3D printing in the construction industry have shown reduced values compared to conventional manufacturing methods. If more environmentally friendly soil-based materials are used, then further improvements are noted in the results. Alhumayani *et al*. (2020) presented lower environmental impacts than concrete to curb global warming in their study on cob-based materials both for conventional and for 3DP processes. Likewise, Weng *et al*. (2020) studied 3DP of a prefabricated unit, demonstrating significantly reduced environmental impacts compared to a similar precast concrete unit.

Construction time and cost reduction

In the same work by Weng *et al*. (2020), their comparisons between precast and 3DP approaches demonstrated significant cost reductions, while achieving higher productivity levels. Along similar lines, the work by Kontovourkis and Tryfonos (2020) discussed the contribution of 3DP towards shorter production timelines. In particular, comparisons were established between non-conventional and standard wall components using 3DP and in both cases the results showed similar printing times. These results differed remarkably from a comparison between two similar walls based on a standard construction approach, as the complex shapes especially when compared with conventional forms, required lengthier construction times. The reduction of construction time impacted on construction costs and in consequence increased productivity. Increasing productivity for the construction of complex structures using digital fabrication techniques was discussed in the work of De Soto *et al*. (2018). In the work by De Schutter *et al*. (2018) the potential cost-effectiveness of digital manufactured concrete in comparison with conventional construction approaches was discussed. Finally, productivity increases of almost fifty percent compared to conventional precast construction was noted by Weng *et al*. (2020) in their study on 3D printed techniques.

Improving construction precision

Construction precision can also be improved due to the computerized technology applied in construction-scale 3DP, especially in the development of complex shapes. In the work of Zuo *et al*. (2019), an attempt to quantify the accuracy of large scale 3DP was discussed in accordance with other parameters such as layer resolution and printing time, discussing at the same time the challenges and opportunities that 3DP applications are raising within the construction industry. The precision of machining positions was discussed in the work of Mechtcherine *et al*. (2019), together with geometrical accuracy for the development of additive concrete construction applied to conventional construction industry techniques.

3D printing in urban scale

While several attempts to apply 3D printing technology at an exploratory level may be found, it is still at a formative stage within the industry. In Fig. 6 below, the main applications of 3DP to the construction industry are based on a study by Boston Consulting Group (Immensa Additive Manufacturing, 2019; De Laubier *et al*., 2018). In this graph, the commercial adoption of 3DP in the form of moulds, architectural models and interior design is shown. Achieving the full potential of 3DP moulds and interior design is projected over two years while the marketing of 3DP building components is expected within five years. Its application to buildings and bridges is still at a prototyping and project demonstration stage. Nevertheless, examples from different parts of the world have successfully demonstrated 3DP applications, mostly for house and office-building developments (Kontovourkis, Tryfonos & Georgiou, 2019).

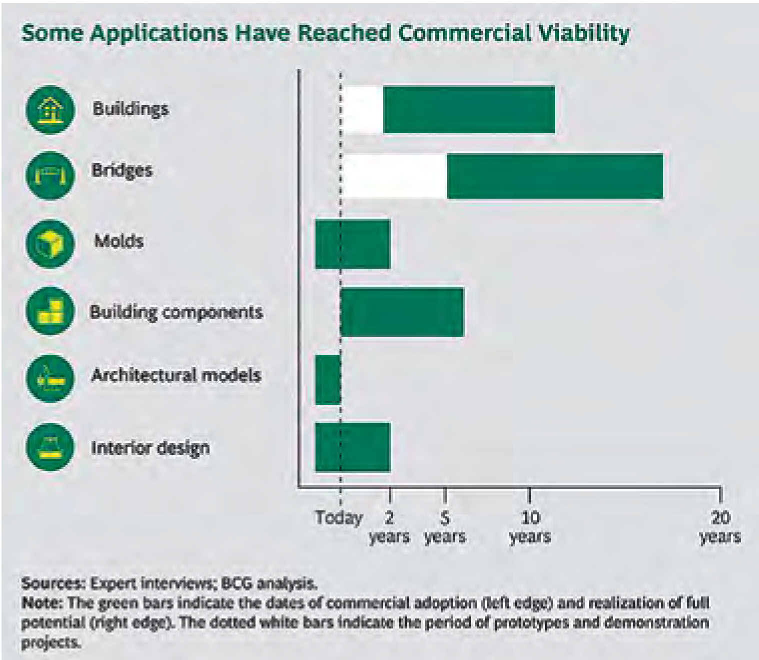

Figure 2.3.6. *Boston Consulting Group (Credit: De Laubier et al., 2018)*

The question of whether 3DP technology can potentially be applied on a larger scale, particularly in urban design and construction, in order to solve problems arising from the development of infrastructure and urban fabric, is under serious consideration. Two examples of scale-jumping case studies are the TECLA 3D printed habitat (Figure 2.3.7), introduced by WASP **and Mario Cucinella Architects in Bologna, Italy (3dWasp, 2020),** and the Printed neighbourhood in Tabasco, Mexico. In both cases, the aim is the provision of a new form of 3D printed habitats, affordable to all, that can solve issues related to exponential population growth and poverty in several parts of the word.

Figure 2.3.7. *WASP is using its Crane 3D printer to build TECLA | Image via WASP (3dNatives, 2020).*

2.2 City Models

This section shows several examples of ICT technologies and construction technologies, which have been applied to city models at an urban scale.

a) City models for ICT

Smart cities are characterized by the application of information and communications technology to the management of urban spaces. The solutions are linked to supply networks, mobility and waste, among other aspects that are key to the daily operation of a city. The objective is to achieve greater efficiency and to confront such challenges as pollution and aging populations.
One of the most outstanding projects in the field of energy efficiency and management, both in Spain and worldwide, is **Malaga Smart City**.

Figure 2.3.8. *Malaga Smart City (Credit: Farrás Pérez, 2020)*

The four-year Project that began in 2009 with a budget of 31 million Euros comprises several initiatives:

> Smart Grids: intelligent management of energy distribution;

> Smart Generation and Storage: self-generation and storage of renewable energy;

> Smart Energy Management: efficient management of the final use of energy;

> Smart and Informed Customer: informing, raising awareness and promoting citizen engagement with responsible consumerism.

The final objective of the project is precisely to meet the EC objectives established in its 20/20/2026 plan, which for the city of Malaga will imply reducing atmospheric emissions by 6,000 tn. of CO2. Some of the projects launched in Malaga are as follows:

> **PALOMA project** (an acronym for Prototype for Alternative Operation of Mobility Assets) promoted by Endesa, Alstom and Mansel - consisting of the underground installation of a fast charging system (200 kW) at the final stop of a bus route. The objective of this initiative is to double the autonomy of the buses without changing the arrival times for passengers, with the consequent advance in the technological innovation that surrounds electric mobility.

> **V2G project** (Vehicle to Grid) post for charging electric vehicles in Spain and the Zem2all project (Zero Emission Mobility to All) program, which between 2012 and 2016 developed the first large-scale demonstration project for electric mobility in the country.

> **PASTORA project** (an acronym for Preventive Analysis of Smart Grids with Real Time Operation and Renewable Assets Integration) hosted by the Smart City Malaga Living Lab. Endesa leads this consortium that applies AI techniques for concentrating investments through the analysis of data obtained from electronic meters and sensors installed at different points on the network, which system operators also use to predict possible incidents.

> **MONICA project** (Advanced Monitoring and Control of Medium and Low voltage distribution networks). Information supplied from smart meters and sensors has enabled medium and low-voltage network status to be determined in real time, something that, until now, had only been applied to the high-voltage network.

b) City models for Construction technology

3D Printed neighbourhood. Tabasco, Mexico

The first entirely 3D printed community, to accommodate 50 families, is currently under construction in Tabasco, Mexico (Figure 2.3.9). The aim is to replace self-made houses, which are unable to withstand earthquakes and flooding, with resilient, weather-proof, 3D printed, concrete houses. The first two houses were recently completed, and the team (New story and ICON) plans to finish all 50 by the end of 2020 (ICON, 2020).

Figure 2.3.9. *3D Printed neighbourhood (Credit: New Story, 2020)*

Each house has two bedrooms, a living room, a bathroom, and a kitchen with a total surface area of 150 m2. Its flat-roof is reminiscent of a traditional southwestern design.
Once the design is drawn up using a 3D modelling program, the file is directly sent to the 3D printer, Vulcan 2. The 33-foot machine pumps out a concrete mix one layer at a time. The machine starts at the bottom of the house, layering the concrete all the way to the full height of the wall upon which a roof is placed. In this process, certain concrete properties are needed, especially sufficient stiffness and a low slump so that its shape is retained following extrusion through a nozzle (Bhavnagarwala, 2020).
From start to finish, the entire process takes 24 hours, speeding up home construction, although workers are still required to attach the roof and doors, and to install the plumbing.
Using this technology, a customized house can be quickly built with less waste, at a lower cost than traditional homebuilding methods, and will be strong enough to withstand natural disasters (Intelligent living, 2020).

TECLA 3D printed habitat. Bologna, Italy

TECLA is a visionary proposal for a 3D printed habitat for sustainable living. WASP 3D printing company and **Mario Cucinella Architects** aspire to develop 3D printed habitats as innovative eco-housing, offering the opportunity of low-cost housing for everyone within a short space of time in countries with rising populations (Figure 2.3.10). The 3D printing process will employ locally gathered reusable and recycled materials and the first prototype will be 3D printed near Bologna, Italy (3dWasp, 2020; 3dNatives, 2020).

Figure 2.3.10. *TECLA, a 3D printed global habitat for sustainable living* *(Credit: 3dWasp, 2020)*

Photocatalytic concrete tiles, Valencia and Madrid, Spain

New anti-pollution concrete pavement tiles were laid on the sidewalks of Félix Pizcueta street in Valencia, Spain. These concrete pavement tiles when exposed to sunlight produce a chemical reaction that absorbs harmful components from the air, thereby cleaning the atmosphere (Ecoavant, 2015). Contaminants adhere to the tile surface and the reactants are then dissolved in dousing water or rain. The installation was funded by the Light2cat European project (Light2cat, 2015), set up to study the impact of the pavement exposed to sunlight and atmospheric pollution. The technology absorbed 72% of the nitrogen monoxide within the paved area of the city centre, while nitrogen dioxide was reduced to around 30%. Finally, this technology will enable building public infrastructures and buildings capable of reducing air pollution in less sunny climates and indoor environments.

Another example of Photocatalytic concrete tiles was performed in Azca, one of the most important financial centres of Madrid, Spain (Figure 2.3.11). In the same way as the tiles located in Valencia, these pavements can eliminate recurrent atmospheric pollutants such as nitrogen dioxide (NOx), through an oxidation process that is activated by the energy of the sun. In addition, the pavement design used a selection of materials that facilitates recognition of the main routes for people with visual disabilities.

Figure 2.3.11. *Concrete paving tiles placed in Azca, Madrid (Credit: Quadro, 2020).*

3 Discussion and Conclusions

The various technologies and their examples presented in this chapter have shown their application at different levels, both in terms of scale jumping in size and in terms of quality. However, the examination of individual examples of emerging technologies and their application within the built environment will not automatically imply that each technology is applied both to buildings and at city scale.

Thus, ICT technologies, which have been classified as supporting technologies (see Figure 2.3.1) and are implemented at multiple levels, from building scale in the built environment to the city scale, have been applied to several examples of City Models. In particular, among the various technologies that develop Smart Grids, Smart Generation and Storage, Smart Energy Management and Smart and Informed Customer systems appear in several city examples and have clearly influenced the way policy makers, designers and citizens perceive new cities. Thus, ICT technologies that apply smart systems to manage city issues through restorative and regenerative approaches and that have the potential for further implementation are addressed. Furthermore, scale jumping can be observed both in size and in quality .

With regard to scale jumping in size, some of these ICT technologies could potentially take effective control over large areas, influencing large numbers of people within the built environment through their implementation in different areas. With regard to scale jumping in quality, both new perspectives and research directions are observed, as well as new commercial markets. These breakthroughs are due to the capability of ICT technologies to provide smarter solutions than those currently in use, but also to extend building and infrastructural networking with people in multi-disciplinary and interconnective systems.

On the contrary, construction and operational technologies have been classified as technologies implemented in the built environment (see Figure 2.3.1), and more specifically have found application in the building sector or are intended for building-sector applications. Their application and scale jumping, both in size and quality, is at an early stage compared to ICT technologies. In particular, it is observed that emerging materials and construction technologies, despite their proven ability to improve the conditions of the built environment and to contribute to both restorative and regenerative sustainability, are still at an early stage of application at city level. It may be due to different factors, such as the early exploration of their technological and material potential, making them less acceptable to the market community and stakeholders. Their future incorporation in real projects should prove their applicability on a larger scale than merely the building scale.

In conclusion, both the supporting ICT and the built environment technologies that are used in construction and operation, have great potential and can expand their capabilities to contribute beyond the building scale, to influence more people and to provide positive responses to current social, economic and sustainability issues within contemporary society. Ever-increasing research into the area of emerging technologies will also lead to new research lines and their continuous development. The ultimate aim will be to achieve a level of technology readiness that will attract market interest and convince the vast majority within contemporary society of the clear benefits of such alternatives.

Acknowledgements

The authors would like to thank Miguel Angel Gómez Zotano, Aranzazu Galán González, Jelena Bleiziffer and Emanuela Giancola for their valuable comments and involvement in productive discussions during the online meetings and for their contributions when developing the general framework for scale jumping of emerging technologies that is depicted in Figure 2.3.1.

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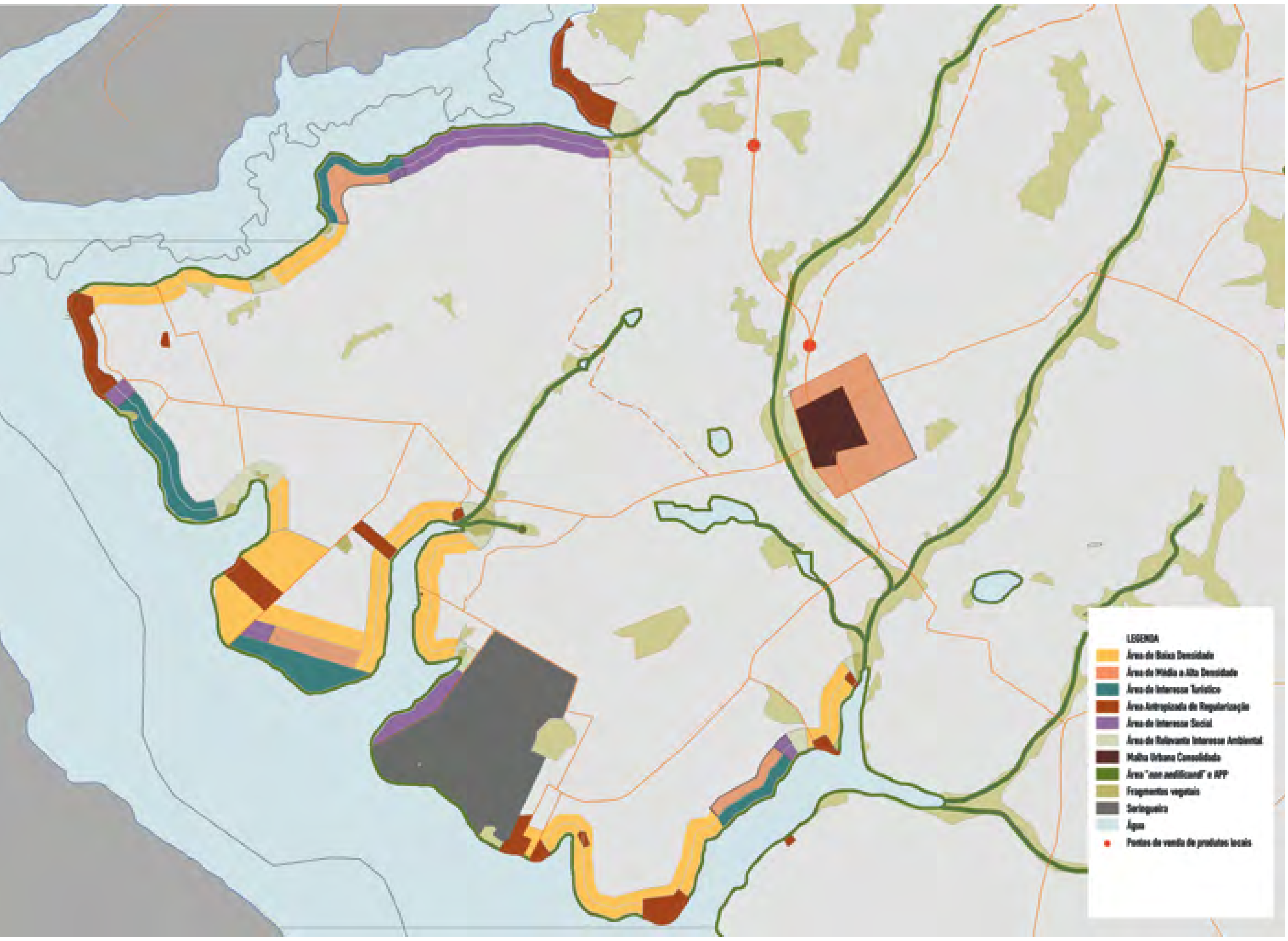

Proposed zoning for the development area of Agua Comprida (Credit: Eduardo Blanco and Tiffany Liu)

2.4

From Regenerative Buildings to Regenerative Urban Projects: Design frameworks to scale up within the area of regenerative practice

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Summary

In this chapter, a discussion will be presented of design frameworks and assessment tools that are useful for boosting the scale jumping of regenerative design practices and the paradigm shift.
Our main objectives will be to identify existing design and assessment frameworks, to describe the way they work and how they can contribute to scale-jumping regenerative design, as well as to identify short-comings and opportunities.
We showcase and discuss ten design frameworks that practitioners can use to foster regenerative projects on an urban scale.

Addressing scale jumping

We will concentrate on the potential of scale jumping up to area level; in doing so, we will focus on tools that can help to foster area scale jumping of regenerative projects at less fully explored urban scales than the buildings, encompassing neighbourhood, district, city, and regional scales.

From Regenerative Buildings to Regenerative Urban Projects: Design frameworks to scale up within the area of regenerative practice

By Eduardo BLANCO, Cristina JIMENEZ PULIDO, Dorota KAMROWSKA-ZALUSKA, Jonas GREMMELSPACHER, Melinda OROVA

1 Introduction

Design and assessment frameworks have been essential tools for mainstreaming contemporary sustainable/green building practices. Exemplary tools, such as LEED, BREEAM, CASBEE, and other rating systems, have shaped the comprehension of sustainability among designers and how they translate it into built space design (Cole, 2012).

Regenerative design proposes a radical paradigm shift from sustainability practice in the built environment, by going beyond its site boundaries to stimulate positive interactions within its surrounding environment (both human and natural systems) (Craft *et al.*, 2017). New tools are necessary to help guide designers through this process (Hes and Du Plessis, 2014).

Many existing design frameworks and rating systems adopt regenerative design principles to advance green building practices, such as the Living Building Challenge (LBC). However, regenerative design frameworks have had a primary focus on the building scale, and quite recently, these design frameworks have started to address larger scale issues.

As cities are multi-level and nested systems (Hill, 2004), it is crucial to foster regenerative practices across all urban scales. Our focus is therefore on scales that go beyond simply the building, such as neighbourhoods, districts, cities, regions, and territories, as shown in *Figure 2.4.1*.

The objective of this chapter is to identify and to showcase frameworks, discussing those that are useful to boost area scale jumping of regenerative design practices.

As design frameworks, we understand any tool, framework, certification, protocol, and others (with or without a third-party evaluation and label) that provide prescriptions and guidance to architects and urban designers on the design phase of regenerative urban projects. In the first of two sections, the design frameworks are summarized and the case studies are presented, before we draw conclusions from a discussion in the second section concerning further challenges and necessary developments to achieve larger-scale impacts.

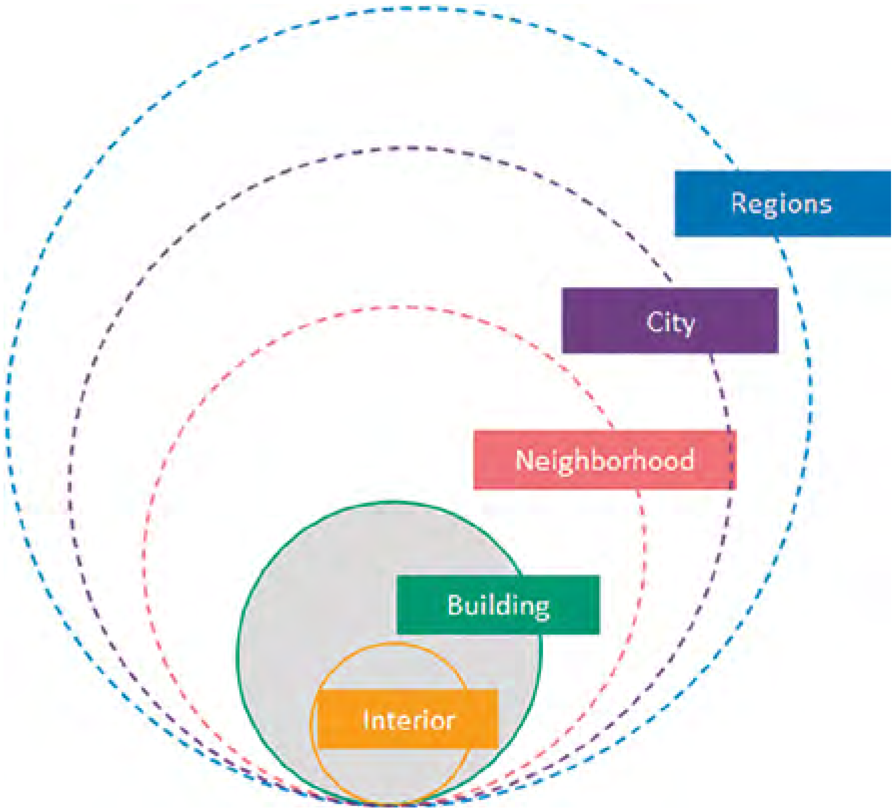

Figure 2.4.1. *Urban nested scales - Sustainable and regenerative practices have been focusing on lower scales: it is time to scale up.*

2 Design frameworks

Using a collaborative brainstorming approach, we identified ten design frameworks that can support regenerative practices at a larger urban scale than buildings. Initially, the sub-task members listed and briefly described the design frameworks of which they were aware and that they had already used or studied in their regenerative design practice, amounting to eighteen frameworks. In the next step, we first selected only those related to the urban scale for further analysis, with relevant online data for their documentation, and then those which appear to be more frequently used in design practice. These two steps allowed us to reduce our sample to the ten design frameworks presented and discussed in this document.

They are:

- Integrated Design Process (IDP) (Busby, Perkins+Will and Stantec Consulting, 2007);
- LENSES - Living Environments in Natural, Social, and Economic Systems (Plaut *et al.*, 2012);
- Ecosystem Services Analysis (ESA) (Pedersen Zari, 2012);
- Strategic Environmental Assessment (SEA) (UNECE, 2003, 2018);
- Living Community Challenge (LCC) (The International Living Future Institute, 2014);
- SITES - Sustainable Sites Initiative (Sustainable SITES Initiative, 2014);
- One Planet Living (Bioregional, 2018);
- The Reference Framework for Sustainable Cities (RFSC) (RFSC, 2016);
- Well Communities (IWBI, 2015);
- CityLab (SGBC, 2019).

Each of these frameworks is briefly presented in this chapter using a standardized factsheet. In these factsheets, it is stated whether the framework is a certifiable rating system or not and whether it has a significant focus on ecological, social or economic aspects.
We further discuss how the frameworks are used and how they contribute to regenerative design scale jumping. In each factsheet, we illustrate the application of the frameworks with a case study, giving insight into its field application and possible results.
At the end of this chapter, the actual strengths and shortcomings of these frameworks are discussed, as well as the opportunities for scale-jumping regenerative design on an urban scale.

2.1 Integrated Design Process – IDP

Type:

☐ 3rd party certification
☑ Not certifiable

Main focus:

☑ Ecological aspects
☑ Social aspects
☑ Economic aspects

Description:

The Integrated Design Process is a framework used for urban and other design projects. It is based on circular management and committed stakeholder collaboration at an early stage; key elements for the design of projects with outstanding environmental performances (Busby, Perkins+Will and Stantec Consulting, 2007).
The approach relies on collaborative decision-making, set up with a shared vision towards environmental and social goals, and with a holistic understanding of the project.
In comparison to conventional design in urban projects, where the client and the designer agree on a general project orientation before engaging other stakeholders (such as environmental and social consulting companies), the IDP promotes inputs from each stakeholder from the very first design steps.
In this process, sustainability is integrated into the design, avoiding simplistic sustainable approaches, such as solutions based on remediation and compensation. Working with an integrative design approach means that the team takes advantage of opportunities and influences the overall sustainability of the project. It also means that the sustainable strategies are not rejected during the project design phase, due to insufficient time or high budgets.
Employment of an IDP Facilitator (IDP Champion) is essential from the outset when implementing an integrated design process, which will assure continuity in the integrative design process, engagement among stakeholders, and a shared vision of the project within the team.
IDP can be applied at every urban scale and throughout the entire project life cycle (Pre-design; Schematic Design; Design Development; Construction Documentation; Bidding, Construction, and Commissioning; Building Operation; Post Occupancy; and End of Life).

Contribution to scale-jumping regenerative design:

Larger urban-scale projects face challenges that are similar to buildings, with regard to their design processes, stakeholder visions, and integration of sustainable and regenerative strategies. This way, IDP can

allow the integration of new stakeholders (health professionals, ecologists, sociologists, etc.) within the project and manage them to create a shared and regenerative vision for urban scale projects.
IDP has the potential to catalyse holistic comprehension and an iterative process that appears to be necessary for regenerative projects. IDP can also be associated with certifiable frameworks such as Living Building Challenges (LBC), Sustainable Sites Initiative (SITES), Leadership in Energy and Environmental Design (LEED), etc.

Framework evolution:

IDP is a very flexible framework that can be adapted to the needs of each project. Research and discussion regarding its application has proliferated in urban sciences, and several detailed guides can be consulted (see More resources below).

Case study: Dockside Green

Location: Victoria, BC, Canada
Year: 2009
Area: 15 ha.

Dockside Green is a Canadian mixed-use neighbourhood project in Victoria, designed by Perkins+Will, using the Integrative Design Process.
The project was focused on the regeneration and redevelopment of a port brownfield zone in Victoria. The design team achieved a neutral greenhouse project that successfully regenerated the local ecosystem and created a thriving social and economic context.
During its initial design, the multi-stakeholder team identified risks and opportunities at the beginning of the project. The entire team worked closely through a series of collaborative design sessions, to devise a project that would catalyse synergies to optimize performance and minimize project costs.
The project includes renewable energy production, on-site grey and wastewater management using nature-based solutions, the integration of several ecological structures such as green roofs, bioswales, and parks, and strategies to foster quality of life within the community.
The project design met with no objections during the approval process, showing that deep integration of local stakeholders and a shared vision at the design phase can have positive impacts on project phasing and associated costs.

Figure 2.4.2. *Dockside Green (Credit: Photo by adrimcm on Flicker CC-BY-NC 2.0).*

More Resources:

> Roadmap for the Integrated Design Process. Busby, Perkins+Will, Stantec Consulting. 2007.
> Integrated Design Process Guidelines. Stefan Amann, e7 Energie Markt Analyse GmbH, MaTriD.

2.2 LENSES - Living Environments in Natural, Social, and Economic Systems

Type:

☐ 3rd party certification
☑ Not certifiable

Main focus:

☑ Ecological aspects
☑ Social aspects
☑ Economic aspects

Description:

The LENSES Framework aims to guide teams through the regenerative development process. The framework relies on facilitators who guide designers and stakeholders towards an understanding of the context, identifying regenerative potential, formulating a plan, and implementing initiatives. The framework pro-

vides a structured process for visualizing and achieving the full potential of a regenerative project (Plaut *et al.*, 2012).
LENSES is not a rating system, and is not certifiable, but it is a flexible framework that can be used at many urban scales during the design process. The process is strengthened by a visual framework that leads users through systems thinking in an accessible way, aiming to create a project that increases vitality, viability, and a capacity to evolve.
The LENSES Framework is made up of three interrelated "Lenses" (Vitality Lens, the Flow Lens, and the Foundation Lens). Each lens has a function and serves as a visual aid to the process. Together the three lenses help teams to understand the whole and to identify regenerative potential.
The Vitality Lens represents the degenerative and regenerative paradigm and is used to introduce the concepts of regenerative design and development to advance stakeholders and to facilitate brainstorming for identifying regenerative opportunities. The Flows Lens represents interrelated aspects of a system that makes the whole, assessing how the flows, relationships, and patterns change over time, promoting a deep understanding of the context. The Foundation Lens activities engage users in creating a shared sense of commitment, after walking through the two previous lenses.
The LENSES process consists of three phases that are assured by a 3rd party facilitator: Pre-Work, Discovery and Workshops, and Implementation.

Contribution to scale-jumping regenerative design:

The development of the LENSES framework was based on regenerative concepts and can be applied in several urban scales. Its application has mostly been tested in larger urban scales such as neighbourhoods and larger land developments.
Rather than focusing on performance, the tool is focused on the design process and its potential development, so its framework can be easily integrated into the design process with a view to qualifying for certifications such as LEED, LBC, BREEAM, among others.

Framework evolution:

The Lenses Framework was initially developed in the United States by the Institute for the Built Environment at Colorado State University. The Center of Living Environments and Regeneration (CLEAR) currently manage the framework and its ongoing development.

Case study: Nunduk - Seacomb West

Location: Seacomb West, Victoria, Australia
Year: 2016
Area: 680 ha

Seacomb West is a large residential and mixed-use eco-development in south-eastern Australia, on the shores of Lake Wellington, where the LENSES framework has been applied to regenerate the site. The entry of sea water into the lake system resulting from human-induced activities and the resulting salinity of the waters had severely degraded the inland waterways. While previous conservation efforts met with limited success, the process of regenerative development was considered for its potential to revitalize the area.
The LENSES Framework was facilitated through three workshops at which guiding principles and work flows, past history, and relations were defined, to bring renewed vitality and vibrancy both to the ecosystems and to the surrounding community.
Based on the Pre-Work, Workshops, and additional research, the team identified critical relationships that needed to be strengthened and key initiatives for the design, such as pre-fabrication, healthy housing,

transportation system design, local food production, empowerment of local stakeholders and tourism development. The process resulted in an innovative masterplan that proposes beneficial strategies for the ecosystem, local biodiversity and the community. The project includes approximately 800 housing units, a community park, shops, a business centre, a marina, a hotel, conference centre and restaurants. Its design through a masterplan emphasizes social development and opportunities for economic viability.
The LENSES Framework assisted the project teams to set goals and policies that go beyond sustainability moving into the realm of regenerative design and generating regionally appropriate decisions.

Resources:

> Design for Hope. Dominique Hes and Chrisna du Plessis, 2004.
> https://www.clearabundance.org/lenses/
> https://www.seacombewest.com.au/regenerative-design/

2.3 Ecosystem Services Analysis (ESA)

Type:

☐ 3rd party certification
☑ Not certifiable

Main focus:

☑ Ecological aspects
☐ Social aspects
☐ Economic aspects

Description:

Ecosystem Services Analysis (ESA) is an urban design tool that uses ecosystem-level biomimicry theories to facilitate the design of regenerative projects at several urban scales. Maibritt Pedersen Zari theorized the tool and tested its approach at city scale (Pedersen Zari, 2018, 2019; Hayes, Desha and Gibbs, 2019).
The frameworks rely on a deep understanding and an assessment of the original ecosystem functioning, before any urban project, or a desired previous state, to find inspiration in the local patterns of the urban design process. The assessment is used to define objectives that will guide designers during conception, leading them to promote healthy and functional ecosystems. The framework relies on the notion of ecosystem services to assess ecosystem functioning.
The framework consists of 4 steps: (1) A preliminary evaluation of the ecosystem services provided by the original or previous ecosystem that existed on the project site; (2) An assessment of current ecosystem services generated at the site; (3) A comparison between the results of steps 1 and 2 that leads to a gap analysis and the definition of performance goals; and, (4) Investigating solutions to achieve the defined objectives followed by an evaluation, and if necessary, re-design.
Maibritt Pedersen Zari proposed seven main ecosystems service to be assessed, that are: Climate regulation; air, water and soil purification; habitat provision; nutrient cycling; provision of freshwater; provision of fuel/energy for human consumption; provision of food.
Similar approaches, such as the Ecological Performance Standards, developed by Biomimicry 3.8 (Hayes, Desha and Gibbs, 2019), and the Pre-Development metrics, developed by Mithun (Pedersen Zari, 2018),

have been proposed and tested in urban projects (such as the Lloyd Crossing and the Lavasa Hill projects), using the replication of ecological processes and performance within urban areas (Buck, 2017; Blanco *et al.*, 2020).

Contribution to scale-jumping regenerative design:

The ESA framework mainly facilitates the design of urban projects at both neighbourhood and city scales. Ecosystem functioning inspires designers relink urban projects to site-specific ecological functions through ecosystem service indicators, a widely explored concept in conservation and ecological sciences. The framework, and similar approaches to emulate ecosystem metrics, has been applied both theoretically and practically with inspiring results beyond the building scales.

Framework evolution:

The framework is evolving with further research into ecosystem-level biomimicry. The main objective is to develop a web-based tool that relates ecosystem services to design strategies, concepts, technologies, and case studies in user-friendly formats.

Case study: Lloyd Crossing

Location: Lloyd District, Portland, USA
Year: 2004
Area: 800 ha

Lloyd district, with over 800 ha, is a mixed-use district in Portland, Oregon, USA. In 2004 the neighbourhood was the object of a Sustainable Development Urban Plan, with the aim of catalysing transformations at district level, so as to strengthen its identity and to regenerate ecological and social systems.
The project was tasked with a mission to move towards a functional symbiosis between the urban system and its surrounding ecosystems through their integration. To do so, the design team used an approach similar to the Ecosystem Services Analysis, with an in-depth diagnostic analysis of the previous ecosystem and its components (a mixed coniferous forest). They then compared it to the existing urban ecosystem at that time. These steps assisted the project design teams when setting their objectives and helped them to innovate the design of the solutions.
The design team used thirteen indicators to understand the previous local ecosystem, assessing habitat availability, vegetation cover, rainfall and water catchment flows, solar input, oxygen production and carbon fixation.
Among the design strategies, the project set the objectives of limiting the use of energy and water to the amounts available on-site and recovering the habitat structure. The project aims to collect, treat, store and reuse rainwater to meet net-zero urban water use. The water should be treated using Nature-Based Solutions (NBS) and wastewater is reused so that water consumption can be reduced in the buildings, assisted through high-performance fixtures and user education. The plan contains proposals for energy solutions that include the insulation of buildings, economic fixtures, heat transfer between buildings to reduce energy consumption and renewable solar energy supplying 100% of local demand through solar panels.
Regarding natural habitats, several strategies were proposed to extend the vegetation canopy from 14.5% to 30%; for example, new public green parks, green roofs, networks of green routes and green areas within private property.
Placemaking and active mobility strategies have also been planned, aiming to foster a new socio-economical dynamic within the district. The Lloyd Crossing project was designed with a longer-term perspective, with a time horizon until 2050.

Resources:

> Regenerative Urban Design and Ecosystem Biomimicry, Maibritt Pedersen Zari, 2018, Routledge.
> https://www.ecolloyd.org/

2.4 Strategic Environmental Assessment (SEA)

Type:

☐ 3rd party certification
☑ Not certifiable

Main focus:

☑ Ecological aspects
☑ Social aspects
☑ Economic aspects

Description:

The Strategic Environmental Assessment (SEA) framework promotes the design of strategies, plans, and programmes through holistic and sustainable approaches. The framework is not relevant for projects, but for planning related to larger scales. It proposes an iterative process for environmental and design teams to assess and to include environmental, social, and economic impacts and their consequences for decision-making processes (UNECE, 2003).
SEA provides inputs to the design team and ensures that the results are incorporated, improving the environmental, social, and economic results of plans and programs. The framework is a step-by-step procedure with a focus on analysing and communicating environmental and health considerations related to development strategies, plans, and programmes, usually proposed by government. Considerations are gathered to set up a diagnostic baseline. The design team draws up development scenarios through the diagnostic baseline and stakeholder consultation, leading to a comparison between the positive and the negative points of each scenario. The SEA process must be documented and participatory, adding transparency and public trust in decision-making. The SEA tool has shown results that present choices for economic development that benefit human health and the environment alike. Its use mainly within Europe has been expanding.
The SEA framework is appliable to several kinds of plans and programs, including town and country planning and land use. Even if it is a flexible framework that can be adapted to each project area, some standard steps are usually followed during a SEA process: Screening (determining whether a SEA is necessary); Scoping (setting the scope for the SEA); Baseline analysis (diagnostic and analysis of the context, existing conditions, and trends); Impact evaluation, including alternatives, and formulation of mitigation measures; Documenting the SEA report; Quality control of the SEA; Inputs into decision-making; and, Environmental monitoring of implementation.
The conclusions and recommendations provided by the SEA, together with comments from relevant stakeholders, are all considered in the decision-making process.

Contribution to scale-jumping regenerative design:

The Protocol on SEA is an international agreement that sets out the procedural framework for SEA implementation. The framework promotes a holistic view, comprehension of ecological and social aspects of the place, and its economic logic and needs, which feed into the design of plans and programmes that can catalyse changes. The application of the SEA framework is an excellent opportunity to scale-jump regenerative practices for their application in public policy and the planning of larger areas, such as masterplans and regional development programs, so that positive impacts may be targeted.

Framework evolution:

The SEA protocol was adopted in 2003 and has been in force since 2010. The protocol has 28 Parties (as of 30 March 2016), and examples of its application, mostly in Europe, are multiplying.

Case study: Sustainable Urban Development Plan of Agua Comprida

Location: Agua Comprida, MG, Brazil
Year: 2019
Area: 675 ha

Água Comprida is a small Brazilian town located on the banks of the river Rio Grande, a major leisure attraction in the region. The urban network is relatively small and compact, featuring a population of 2,000 inhabitants. However, a succession of residential developments of touristic interest has sprung up on the river banks, creating rapid population growth within the region and a disorganized process of urbanization, associated with several socio-ecological impacts.
The municipality decided to draw up a Sustainable Urban Development Plan, so that the community could confront these trends and their negative impacts, with the aim of catalysing social, ecological, and economic regeneration within the region. It requested the design team, led by Eduardo Blanco and Tiffany Liu, to perform a Strategic Environmental Assessment (SEA) of the Plan.
The project started with the development of a broad socio-ecological diagnostic to draw up the SEA baseline. This diagnostic mainly included secondary data and stakeholder perceptions of the local ecosystem (topography, local species, actual land use, polluted sites, protected zones, connectivity, etc.) and its social profile (demography and growth trends, social patterns, cultural heritages, stakeholder identification, local governance, etc.), as well as economic data (main economic activities, local industries, available investments, ongoing development project, etc.). After this baseline, three development scenarios were designed with broad stakeholder participation.
These scenarios were submitted to the SEA team, which evaluated the positive and negative impacts of each one and drew up guidelines, aiming to reduce the negative impacts and to amplify the positive ones. Thus, a final scenario was selected in a participatory approach and further developed into the final development plan version that was submitted for public approval.
Among several benefits, the SEA process was essential to prevent the loss of native ecosystems, to support handicrafts and local agricultural production, and to regenerate deforested green areas. Its proposals led to the design of interconnected green networks across the development area, including social housing programs in the development and structuring the implementation of the development plan into long-term phases.

Figure 2.4.3. *Proposed zoning for the development area of Agua Comprida (Credit: Eduardo Blanco and Tiffany Liu)*

Resources:

> http://www.green-economies-eap.org/resources/1609217_UNECE_HR.pdf
> https://ec.europa.eu/environment/eia/sea-legalcontext.htm

2.5 The European Reference Framework for Sustainable Cities - RFSC

Type:

☐ 3rd party certification
☑ Not certifiable

Main focus:

☑ Ecological aspects
☑ Social aspects
☑ Economic aspects

Description:

The European Reference Framework for Sustainable Cities (RFSC) is an online toolkit for urban management and development actors to improve dialogue and action on sustainability at a local level.
Since 2017, the tool has been enriched to include other frameworks in favour of sustainable and integrated urban development. The current online tool works under several well-known sustainability frameworks, both European and global, such as the United Nations Sustainable Development Goals (SDGs) and the standard ISO 37101-Sustainable development in communities. By doing so, RFSC offers different choices in favour of integrated urban development to define user ambitions, to assess their projects, and to monitor their progress. RFSC is an open and non-binding instrument that offers a multi-purpose decision-making and communication tool for promoting sustainable urban development.
Step by step, the information on this tool explains which actions may help a city or a municipality to develop in an integrated manner. It can be adapted to suit local priorities and different circumstances once it is not a place-specific tool. Indeed, some local contexts can also enrich RFSC.
The RFSC sets out five dimensions (A-E) and 30 objectives for a European vision of tomorrow's cities. The five dimensions are: A. Spatial Dimension, B. Governance Dimension, C. Social Dimension, D. Economical Dimension, and E. Environmental Dimension. The tool is based on a questionnaire that guides users through a series of questions to explore their city's approach to sustainability. According to the responses, the tool provides instruments for their improvement and the monitoring of results.

Contribution to scale-jumping regenerative design:

The RFSC promotes sustainable urban development by linking its objectives with the 2030 Agenda and the SDGs. The RFSC reveals the sustainability profile of the city or municipality (key actors) ambitions, emphasizing where the priorities have been set. It is therefore a very visual tool, because a lot of consideration is given to increase citizen participation and to communicate the goals and the achievements of each city.

Framework evolution:

The RFSC was first designed to support the delivery of the Leipzig Charter for Sustainable European Cities signed by all E.U. Member states in 2007. It was then developed with the contribution of sustainable city experts from a wide range of backgrounds.

Case study: SCoT Sud de Loire

Location: Sud de Loire, France
Year: 2013
Area: 117 municipalities

In 2013, at the instigation of the French National Federation of Urban Planning Agencies (Fnau), the Saint-Etienne urban planning agency was trained in the use of the Reference Framework for Sustainable Cities (RFSC). The RFSC has since been used to review the SCoT Sud Loire (Territorial Coherence Scheme) with the aim of ensuring the coherence of sectoral policies, and it has promoted a truly integrated approach to sustainable development issues at the territorial level.
The territory of Sud Loire, whose main city is Saint-Étienne in France, includes 117 municipalities and 515,000 inhabitants. the region has significant peri-urbanization and weak demographic dynamics. In this context, the SCoT aims to reverse this trend by using a planned revival of the territory's attractiveness and by promoting territorial development in polarities.

Measures were defined in the SCoT relating to the location of housing and activities, to limit the environmental impact of the development, through regulations that encouraged the strengthening of the transport network, as an alternative to private vehicles. The development the SCoT Sud Loire and its implementation therefore presented major challenges, particularly in terms of translating these into prescriptions that provide sufficient incentives to achieve the stated objectives.

The RFSC offers a set of assessment tools that are designed to help communities improve their sustainable development strategy and was therefore relevant to the SCoT process. RFSC generates indicators to identify the strengths and weaknesses of a project, so that appropriate adjustments may be introduced at all stages. The RFSC highlights the themes on which a complementary approach will be necessary, but it also means that the black spots may be identified that cannot be remedied by the SCoT. In the Sud de Loire case, the RFSC facilitated a dialogue between territorial stakeholders, prompting dialogue between the different structures and enabling the implementation of a genuine partnership. It contributed to opening the way to the emergence of new modes of governance of the territory, favouring multidisciplinarity and the integration of public policies.

Resources:

> www.rfsc.eu
> https://sustainabledevelopment.un.org/index.php?page=view&type=99&nr=86&menu=1449
> http://rfsc.eu/wp-content/uploads/2016/03/30-objectives-1.pdf

2.6 Living Community Challenge (LCC)

Type:

☑ 3rd party certification
☐ Not certifiable

Main focus:

☑ Ecological aspects
☑ Social aspects
☐ Economic aspects

Description:

The Living Community Challenge (LCC) is a regenerative design framework and certification program that is focused on the community scale. The framework is related to the Living Building Challenge (LBC), which fosters regenerative design of buildings, aiming to promote the scale jump of the LBC requirements to larger projects, with diverse stakeholders and owners, such as neighbourhoods, districts, and educational campus. The main objective of the LCC is to give guidance to community stakeholders to develop and to implement masterplans that are socially just, culturally rich, and ecologically restorative (Mclennan, Graves and Edmondson, 2017).

As with the LBC, the LCC is organized around seven themes (also called petals: Place, Water, Energy, Health & Happiness, Materials, Equity, and Beauty) and 20 imperatives. Among these imperatives, there is the need for a community food-production area, a human scale and an active mobility design approach, potable water and renewable energy autonomy at the community level, in-site storm and wastewater

treatment, using low impact and nature-based solutions, interdiction of the use of Red List materials on common infrastructures and the requirement for an embodied carbon offset for these same infrastructures and facilities.
The certification process is organized around four steps. The first step is to register the community project, at which time, the "Limits to Growth" imperative is verified to confirm that the project is not under development within green or sensitive natural areas.
Registration is followed by the Planning phase. In this phase, the community stakeholders must develop and submit a vision plan and a master plan for the International Living Future Institute review. These documents work as roadmaps that will lead the community to achieve the Living Community Standard.
Following the approval of the plans and the beginning of the works, the project enters the implementation phase, and the community applies for the "Emerging Living Community" designation. During this phase, the community needs to progress towards the goals defined in the masterplan.
Once the project is partially implemented and planned performance is achieved, the community can apply for full or partial certification.

Contribution to scale-jumping regenerative design:

As the LBC is known as one of the most demanding sustainable building certifications, and it is built upon regenerative concepts, the LCC fosters the application of the regenerative design concepts behind the LBC on a larger scale, catalysing transformation within communities.

Framework evolution:

The LCC is a spin-off from the LBC that is also managed by the International Living Future Institute (ILFI). LCC version 1.2, 2019, was used. With the LBC 4.0 launch in 2020, the LCC framework may be reviewed to assure coherence with the LBC 4.0 requirements.

Case study: Veridian at County Farm

Location: Ann Arbor, Michigan, USA
Year: 2019
Area: 5.5 ha

Thrive Collaborative is leading a project to convert a former youth prison site in Ann Arbor, Michigan, USA, into a Living Community, using the LCC as a framework.
The project relies on several regenerative strategies to reach all of the 20 LCC requirements within the context of the urban regeneration of a brownfield site. The proposal is to dedicate 30% of the land to food production and to use landscape design to restore the pre-existing ecosystem and to connect the community to the adjacent green network.
The Veridian project will also produce its own energy, relying on both solar energy production and a resilient energy storage system. The neighbourhood will offer bike parking and maintenance tools and electrical mobility sharing systems (bike and cars), to encourage active and electric mobility.
Two-thirds of the homes (99 units) will be for sale at the market rate, and a local non-profit organization will develop one-third of the homes (50 units) for low-income tenants, including some who have formerly experienced homelessness.

Resources:

> Living Community Challenge 1.2
> Living Community Challenge 1.2 - Handbook
> https://living-future.org/lcc/

2.7 SITES - Sustainable Sites Initiative

Type:

☑ 3rd party certification
☐ Not certifiable

Main focus:

☑ Ecological aspects
☐ Social aspects
☐ Economic aspects

Description:

SITES is a sustainable rating system that focuses on landscapes. The framework proposes a deep understanding of the place and ecological patterns before the design of landscape projects that protect, improve, and regenerate local ecosystems.
The framework uses the ecosystem services concept and focuses on creating landscapes that contribute to the production of these services for society, improving human wellbeing and the ecosystem's health.
Certification is organized around ten guiding principles that are: 1) Do no harm; 2) Apply the precautionary principle; 3) Design with nature and culture; 4) Use a decision-making hierarchy of preservation, conservation, and regeneration; 5) Provide regenerative systems as intergenerational equity; 6) Support a living process; 7) Use a systems thinking approach; 8) Use a collaborative and ethical approach; 9) Maintain integrity in leadership and research; and, 10) Foster environmental stewardship.
SITES certified projects must have at least 185 square meters, and projects can have buildings or none at all on the site. It is important to note that the framework focuses only on the area from the building skin outwards and not on lesser scales, like the building architecture or interior design.
SITES can be applied to several project type such as open spaces, streetscapes, plazas, commercial, residential, educational/Institutional, infrastructure, government, military, and industrial. In its actual version (v2), SITES includes 18 prerequisites and 48 credits for assessing the site. During the certification, projects can earn a total of up to 200 points, attaining the Certified, Silver, Gold, or Platinum levels.
Among the prerequisites we can find, for example, the need to limit development on farmlands, the requirement to use an integrative design process, the completion of a pre-design assessment, and the obligation to manage rainwater precipitation on site.
All the design process is based on a deep understanding of site logics and ecological functioning that guides the design, the construction, and the operation phases. The framework is organized into sections (site context, design, construction, operations, maintenance, education, innovation) within its respective prerequisites and credits, which need to be developed through an integrated design process

Contribution to scale-jumping regenerative design:

The SITES framework mobilizes regenerative concepts into landscape projects and is appliable in several urban scales, going beyond (and being complementary) to other green building frameworks and approaches such as LEED and LCC. These synergies facilitate its integration in urban projects.
The framework has a deep engagement with regeneration at the ecological level and gives opportunities to designers to create living landscapes that will contribute to the supply of ecosystem services, improving human wellbeing. SITES is among the few 3rd party certifications that mobilize regeneration concepts within its principles, and its application is growing, with several projects in America.

Framework evolution:

The SITES program was developed through the collaboration of the American Society of Landscape Architects, The Lady Bird Johnson Wildflower Center of the University of Texas, Austin, and the United States Botanic Garden. The U.S. Green Building Council has been a long-time supporter in the Sustainable SITES Initiative and incorporated some SITES credit content into the LEED rating system. Likewise, SITES has adapted LEED credits as part of its SITES v2 Rating System. The second version of the framework dates from 2015, with several certified projects, mostly in the USA.

Case study: Phipps' Center for Sustainable Landscapes

Location: Pittsburgh, PA, USA
Year: 2012
Area: 2.9 acres

The Phipps' Center for Sustainable Landscapes is a research, education, and administration facility, launched in 2012, with 2,200 square meters that meet four of the highest green building standards: Living Building Challenge™, WELL Building Platinum, Four-Star Sustainable SITES™ (2019 SITES v2 Platinum) and LEED® Platinum.
The project was built in a former City-of-Pittsburgh Public Works Yard that is entirely paved. There were no natural land covers or ecosystems to conserve or to protect, and the project focus was on regenerating the local ecological structure. The site now manages stormwater using natural systems and features 1.5-acres of new green space with over 100 native plant species. From open meadows to oak woodlands, to water's edge and wetland plantings, a range of ecosystems is represented on-site that respond to the previous changes in the landscape. The project provides food, shelter, and nesting opportunities to endemic wildlife and links the site's landscape to the local green network.

Figure 2.4.4. *Phipp's Center for Sustainable Landscapes (Credit: Larry Wentzel) (CC BY-NC 2.0).*

Resources:

> SITES v2 - Rating System for Sustainable Land Design and Development, Green Business Certification Inc.

> https://www.sustainablesites.org/

2.8 One Planet Living

Type:

☑ 3rd party certification
☐ Not certifiable

Main focus:

☑ Ecological aspects
☑ Social aspects
☐ Economic aspects

Description:

The One Planet Living sustainability framework comprises ten simple principles and detailed goals, together with guidance on sustainable projects. Bioregional created the framework in partnership with

WWF, based on scientific knowledge and many years of hands-on experience (for instance, lessons learnt from BedZED, an environmentally friendly housing development in London, launched in 1997, that is the U.K.'s first large-scale eco-village). The result is a highly flexible framework that is helping organizations around the world to fulfil their sustainability-related ambitions.

The framework is designed to guide users through their design of a project-specific roadmap called the 'One Planet Action Plan'. The roadmap guides users towards a more sustainable future for their organization or project and can be used by a range of different audiences interested in achieving their vision of a better future. Some of the potential users of the framework are developers/housebuilders, businesses, tourist resorts and destinations, schools, and community groups.

The ten principles of the One Planet Living Framework are: 1) Health and Happiness; 2) Equity and local economy; 3) Culture and community; 4) Land and nature; 5) Sustainable water; 6) Local and sustainable food; 7) Travel and transport; 8) Materials and products; 9) Zero Waste; and, 10) Zero Carbon Energy;

The first step in this framework is to consult and commit to the One Planet Living Framework documentation that contains guidance related to each principle and ideas on the goals, actions, targets, and indicators to facilitate the process. The next step is to create a One Planet Living Action Plan. The framework then proposes a paid peer-review process organized by Bioregional to assure performance and transparency and to gain (non-mandatory) project recognition. Afterwards, the action plan moves through implementation, monitoring, reporting, and review phases.

Contribution to scale-jumping regenerative design:

The One Planet Living framework helps projects to manage their carbon emission reductions, resource preservation, and the construction of healthier communities. As a flexible framework, it can be applied at several project scales and has a holistic focus. The peer-review process is not mandatory.

So far, 595,000 people are living in, visiting, and working within organisations, communities, and cities that have committed to One Planet Living.

Framework evolution:

Bioregional was founded as a charity and social enterprise in 1994 to develop more sustainable ways of living. In partnership with the WWF they created the One Planet Living framework in 2003, mainly from the experiences of developing the multi-award-winning BedZED eco-village in South London.

Case study: BedZED

Location: Sutton, London (U.K.)
Year: 2002
Area: 82 homes and 1,405 square meters of workspace

Designed to be carbon neutral, environmentally protective, and supportive of a more sustainable lifestyle, Beddington Zero Energy Development (BedZED) is the U.K.'s first large-scale, mixed-use eco-village. BedZED was initiated in 2002 by Bioregional, developed by the Peabody Trust in partnership with Bioregional and ZEDfactory architects and completed in 2002. The idea for this zero-carbon eco-village was conceived in 1997, through the involvement of Bioregional, architect Bill Dunster, and engineers Arup.

BedZED aimed to achieve significant reductions in climate-changing greenhouse gas emissions and water use, addressing different topics such as energy and water efficiency, low-impact materials, transport, quality of indoor spaces, etc. The project aimed to make it easy for residents to have a greener, lower impact lifestyle. The role play by Bioregional was to act as sustainability advisors to the design team, steering green transport planning, renewable energy solutions, the selection and sourcing of construction mate-

rials, and a 'green lifestyles' programme for residents, transport, local food businesses composting initiatives.
After its construction in 2002, BedZED became famous for its sustainability-related ambitions. The result included developing an ambitious sustainability strategy, promoted by Bioregional in collaboration with the project partners, with new benchmarks in areas such as energy efficiency and greener construction. It remains the most ambitious attempt at all-round sustainability in significant new housing development and has attracted thousands of global visitors. The project was also shortlisted for such prestigious prizes as the Stirling Prize in 2003, and awarded other prizes, such as the Housing Design Award for sustainability from the Royal Institute of British Architects, in 2001. The project development, its challenges and success inspired Bioregional to create the One Living Planet framework.

Figure 2.4.5. *BedZED project (Credit: Tom Chance on Flickr, CC-BY-2.0)*

Resources:

- https://www.bioregional.com/one-planet-living
- https://www.oneplanet.com/
- https://www.bioregional.com/projects-and-services/case-studies/bedzed-the-uks-first-large-scale-eco-village

2.9 WELL Communities

Type:

☑ 3rd party certification
☐ Not certifiable

Main focus:

☐ Ecological aspects
☑ Social aspects
☐ Economic aspects

Description:

WELL is a holistic, performance-based system for measuring, certifying, and monitoring the performance of buildings and communities that impact human health and wellbeing. It is grounded in medical research that explores the connection between health and wellbeing and our living spaces.
The WELL standard defines ten topics as its requirements: Air, Water, Nourishment, Light, Movement, Thermal comfort, Sound, Materials, Mind, Community. The ten topics comprise 110 features, which can be health-related performance metrics, design strategies and policies that can be implemented by the owners and the design team. Some WELL features are categorized as Preconditions—necessary for all levels of WELL Certification. The remaining features are Optimizations that are required to achieve higher levels of certification. The features of the WELL Community Standard do not address the design or conditions within buildings, but rather how they interact with each other in the landscape (IWBI, 2015).
The WELL Community Standard is a pilot project built upon the WELL Building Standard that aims to impact individuals through the public spaces where they spend their time, applying WELL Building concepts to larger scales. Registration with the WELL Community Standard requires that projects meet at least two of the following conditions: 1) Planned population of 500 people or more; 2) Planned total floor area of 50,000 m^2 or more; 3) Planned total building count of 10 or more; and, 4) Total land area of two hectares or more.
Besides, the WELL Community Standard is designed for integrated, mixed-use developments. Therefore, projects must also include at least two of the following: 1) Multifamily residential: at least one building with five or more dwelling units; 2) Office and/or retail: at least one space, employing a total of at least five people; and, 3) Public use recreation or leisure, accessible from dawn to dusk: occupying at least 0.4 hectares, consisting of one or more spaces each at least .02 hectares.
A Well-Communities project needs to be registered before it can be implemented. After project construction and occupancy, the submission of the documentation for review is possible. Following successful documentation review, projects need to submit performance data for the necessary features in the Air and Water concepts. These performance data can be one-time samples or continuous monitoring data for 12 months. With the submittal of the compliant performance data, the project achieves WELL Certification. Projects must apply for recertification every five years to maintain their certification status.

Contribution to scale-jumping regenerative design:

The WELL Communities rating tool contributes toward regenerative design by defining the most comprehensive requirements for healthy communities available on the construction market. Another significant connection between the systems on the two scales is that certification also requires having at least one health and wellness certified building in a WELL community.

As the focus of WELL is mainly on the social aspect of sustainability, the standard has been designed to work in harmony with other green building standards with an environmental focus. WELL is third-party certified through IWBI's collaboration with Green Business Certification Inc. (GBCI), which also certifies the LEED Green Building Rating System.

Framework evolution:

The WELL certification is managed by the North American International WELL Building Institute (IWBI), and independent certification is performed by IWBI and GBCI.
The WELL framework was first published in 2014 for the building scale. The community-scale WELL standard was first developed and published in 2017 and is still in its pilot phase. The building scale standard was updated in 2018 to the WELL v2 version.

Case study: Lot Fourteen

Location: Adelaide, Australia
Year: 2004
Area: 17.3 acres

Lot Fourteen is a visionary neighbourhood in Adelaide, Australia, on the site of the former Royal Adelaide Hospital. The project wishes to transform the area into a place where ideas and innovation come to life, and thousands of people will work, study and visit, through a creation and innovation neighbourhood, bringing together talented start-ups, research and innovation.
The Lot Fourteen Master Plan aims to capitalise on Adelaide's cultural, environmental and economic strengths. It includes a masterplan that identifies the built form and public areas in which an unfolding vision may be awakened of a globally-recognised innovation precinct. The project targets a 6-Star Green Star Communities certification and was the first registered WELL Communities project within Australia, leading the way towards the development of communities that embody sustainability and a commitment to wellbeing.
Through the Well Community, the project offers tenants and their employees an environment that promotes wellbeing with well-designed workspaces and opportunities for planned and incidental exercise and for making social connections.

Resources:

> https://www.wellcertified.com/certification/community/
> International WELL Building Institute (2018) The WELL Community Standard. Pilot
> https://lotfourteen.com.au/

2.10 CityLab

Type:

☑ 3rd party certification
☐ Not certifiable

Main focus:

☑ Ecological aspects
☐ Social aspects
☐ Economic aspects

Description:

The development of Citylab, driven by the Sweden Green Building Council (SGBC), has been an ongoing project since 2010. The certification system has over 1000 contributors with different backgrounds from both scientific and professional areas. Citylab relies on several research projects driven by Swedish universities. During its development, international standards were assessed and tested, including BREEAM Communities. The certification system is adjusted to the Swedish context. In 2019, the third version of the guidelines (Citylab Guide för planering och genomförande 3.0), consisting of a three-step certification process was launched. In the first step, a sustainability-program for the respective district is certified, in the second step, the action plan with measures, and in the third step, an action plan for the execution. All three certifications are subject to independent verification.
A district that is certified with Citylab lays the ground for an environment with equal and secure access for everyone. It has a minimal climate and environmental impact and can withstand climate change. The district is flexible and can be adjusted to changing needs in the future.
The first step of the certification is the project registration. Afterwards, the sustainability-program is developed and certified (Certifiering av hållbarhetsprogram), including an independent inspection and site visit. The sustainability-programme details a strategic policy that establishes common grounds among stakeholders for district development.
In the second stage, a specific action plan for urban development (Certifiering av handlingsplan för stadsutvecklingsprojekt) is certified. The main actor for the urban development project formulates the action plan in the planning stage, before the start of construction. Measures for the execution are defined, first and foremost with a focus on how project planning and process controls should be carried out during the execution phase. During the construction phase, the action plan is followed up with an annual report. Responsibility at this stage is usually in the hands of a municipal or a private actor that oversees the entire urban development. At this stage, action plans for each respective part of the project driven by different actors (Certifiering av handlingsplan för delprojekt) can be certified.
The third part of the certification process (Certifiering av en stadsdels hållbarhet) is dedicated to districts that have been built and are already in use. The goal of this certification is to assess the effective sustainability of a district. The certification can be used in various ways, including the assessment of how effective and financially viable certain measures are and the best way to determine such changes as densification within a district.

Contribution to scale-jumping regenerative design:

Citylab shows great flexibility around which parts of the project can be certified and which measures are taken over several project stages. The scheme fosters sustainable development of the urban district as well as smaller parts such as single buildings or assets. Clearly, it emphasises the need for the use of individual certification systems for every asset included in the sustainability-program of the entire district. By providing different schemes and different stages of certification, Citylab is very accessible for a wide range of actors and thus fosters regenerative sustainability within the whole chain of actors involved in a project. The goal of adjustability to changing needs in the future is a contributor to the regenerative design of urban districts, as changing needs should be possible with the smallest possible change of design and as much reuse of existing structures as possible.

Framework evolution:

The framework has been altered and changed and is currently running in version 3.0, launched in June 2019. The process for updating the standards involves, apart from direct contributors, inspections and the chance for comments from members of SGBC, in representation of professional and scientific representatives of the construction sector in Sweden. With the latest version of Citylab, the third part (Certifiering av en stadsdels hållbarhet) was added and is targeted to improve the regenerative sustainability of whole urban districts by providing a framework both for assessing measures that have been carried out and for assessing and planning measures that increase the sustainability of existing districts

Case study: Sege Park

Location: Malmö, Skåne, Sweden
Year: 2017
Area: 0.25 ha

Project description:
The park that today consists of a large green area with an existing school and pre-school buildings, student accommodation, and a former hospital "Östra Sjukhusområde" is the target of a sustainable urban project that applied for CityLab certification.
Within the project, a total of 12 entrepreneurs are building a new urban development as a testbed for future urban developments. A total of about 1000 apartments are planned to be constructed. Those include rental apartments, privately owned apartments, and privately owned single-family houses in the area that occupies 2 500 m2. Individual projects included, for example, the construction of 150 privately owned apartments in a so-called Neighborhood Hub with a Café, workshop, mini gym, and an apartment for overnight guests.

Resources:

> http://kth.diva-portal.org/smash/record.jsf?aq2=%5B%5B%5D%5D&c=1&af=%5B%5D&searchType=SIMPLE&sortOrder2=title_sort_asc&query=Bakgrund+och+motiveringar+i+utvecklingen+av+City-lab+manual+f%C3%B6r+certifiering+av+en+stadsdels+h%C3%A5llbarhet&language=sv&pid=diva2%-3A1401971&aq=%5B%5B%5D%5D&sf=all&aqe=%5B%5D&sortOrder=author_sort_asc&onlyFullText=-false&noOfRows=50&dswid=1977
> https://www.norrtalje.se/globalassets/stad-och-trafik/norrtalje-hamn/citylab-action-pilotomgang-2016.pdf
> https://www.sgbc.se/certifiering/citylab/det-har-ar-citylab/
> https://malmo.se/Sa-arbetar-vi-med.../Malmo-stads-miljoarbete/Hallbar-stadsutveckling/Miljobygg-strategi-for-Malmo/Sege-Park/Projekt-Citylab-Action---Sege-Park.html
> https://www.sernekebostad.se/hitta-bostad/vara-omraden/kirseberg-malmo/segepark/

3 Discussions and conclusions

The ten design frameworks described and analysed in this chapter have provided an overview of the challenges and opportunities of scale-jumping regenerative design practices up to larger urban scales.
At first, the tools under analysis have found evidence of greater effort within the built sciences to address sustainable and regenerative issues in larger urban scales, such as neighbourhoods, districts, and cities.
This fact converges with greater attention that is given to new tools and approaches that needed to catalyse change at an urban scale, such as those from the Sustainable Development Goal 11 (Make cities and human settlements inclusive, safe, resilient and sustainable) and the New Urban Agenda. In the fields of both research and design, we can see an expanding interest in new frameworks with a specific focus on these larger scales, such as the Strategic Environmental Assessment (SEA) and the Ecosystem Services Analysis (ESA). We can also see that major consolidated sustainable and regenerative rating programs, such as LEED, WELL, and the LBC, are creating pilot rating systems to transpose their requirements from building to larger urban scales, integrating holistic and regenerative approaches.
An interesting perspective is the difference between rating programs with a third-party certification from those that are not certifiable. In our analysis, we have identified five frameworks that are not certifiable and five others that can be peer-reviewed to label and to award a rating to the project.
Regarding their focus on the sustainability pillars, those with a holistic approach, dealing with ecological, social, and economic aspects, are mostly non-certifiable frameworks. At the same time, those that offer certification processes tend to have a narrower focus on ecological and/or social aspects. Figure 2.4.47 illustrates these elements.
We can also observe that only a few of the frameworks address the economic development of the community in depth. Among those analysed, the SEA and the LENSES design process seems to offer more extensive opportunities to explore economic aspects and create regenerative strategies from an economic perspective for communities.
Across these frameworks, we can also identify some recurrent topics. These topics are used to organize the framework guidelines, requirements, and indicators. Some are, for example, local food production, on-site rainwater management, the management of harmful health materials, renewable energy production, and the restoration of ecological structures. If we are to understand how the various frameworks are dealing with the complexity of urban socio ecosystems and our societal and environmental challenges, then these convergences deserve greater exploration and clarification.
It is also remarkable that some of our identified frameworks, such as ESA, SEA, LENSES, and SITES, rely on the development of broad and comprehensive socio-ecological diagnostics before any project design. These diagnostics have primary importance, creating a baseline and a profound anchorage for the design process in the local context and to the logical demands of the site. This trend throws light on the need for a deep understanding of urban social, ecological, and economic logic to be able to foster regenerative development in urban projects.
Regarding environmental and ecological aspects, it is interesting to note that some of the frameworks (such as ESA , LCC and SITES) mobilize contemporary ecological concepts, such as the ecosystem services concept and the dependence of human society on functioning ecological sites, contributing to bypass the gap that has for a long time existed between ecology and urbanism and architectural practice.
The use of the frameworks under analysis also appear to have expanded in urban projects around the globe, as is evident from very many successful case studies. It is also interesting to observe that several of them can also be integrated into other tools for regenerative design at the building scale. They are also flexible regarding the scale and can easily be applied to urban renovation and requalification projects, which are a leading question in contemporary sustainable urban development.

Finally, these design frameworks have an essential role in defining and guiding future design practices and project performance, facilitating the integration of regenerative practices into larger urban projects. It is not that every framework has its roots in regenerative design approaches. Nevertheless, they can be used to foster the scale jumping of regenerative design up to larger scales, and a key element of doing so is a design team with a regenerative mindset. Finally, the frameworks that have been presented are a significant starting point to develop regenerative urban projects even if it still appears necessary to work their holistic approach towards urban socio-ecosystems and overall usability for design teams.

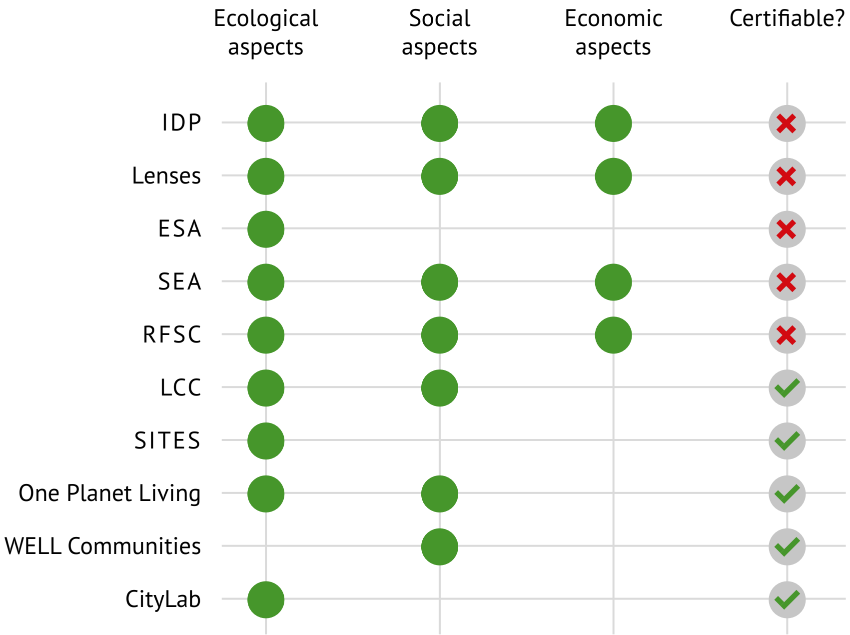

Figure 2.4.6. *Summary of frameworks*

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2.5

EU Policy Documents for Green Transition

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Summary

The chapter presents a well-structured state-of-the-art review of EU-related policy documents for urban development. A systematic screening offers a transparent and coherent picture of the main strategies over the period 2014-2020 and the coming years and two examples of best practice offer a glimpse of how they may be successfully implemented.
The main audience for this chapter comprises city representatives and decision-makers who wish to understand the dynamics of urban policies at a European-level and how those policies may affect regional or local ecosystems in the near future. It likewise offers information on the main goals and instruments of recent EU strategies that may be useful for different stakeholders and organizations in the field of urban development and sustainability consultation.
The contribution of this chapter is two-fold. On one hand, it pictures the state-of-play of the main European or EU-related policy documents concerning urban development and, on the other hand, it demonstrates the potential for their implementation through the introduction of two best practice scenarios.

Addressing Scale Jumping

As the investigative objectives of the chapter are European policies and legislation, the selected documents are screened on the basis of their relevance to scale jumping and their potential to be implemented at regional, urban and district-scale.

EU Policy Documents for Green Transition

By Klaudia ECKER, Željka KORDEJ-DE Villa, Jue ZHOU, Daniel Friedrich, Clarice Bleil de Souza

1 Introduction

Growing cities and metropolitan areas emerge, due to constant change within urban systems, and rapid and significant changes of land use that define settlement patterns. As these rapid challenges vary in form and depth, the spectrum of solutions also covers a wide range of interventions (UN, Global Sustainable Development Report, 2019).

According to Eurostat (Urban Europe, 2016), over two-thirds of the EU population live in urban areas, which are responsible for 80 % of energy use and generate up to 85 % of Europe's GDP. As cities are the engines of the European economy, these places are also where complex socio-economic problems occur, which explains the increased significance of urban policies and regional initiatives. Between 2014 and 2020, 50% of European Regional Development Funds (ERDF) have been invested in urban areas, while urban development strategies have only strengthened with 6% of ERDF.

The Sustainable Development Goals, launched by the United Nations in 2015, mention cities as hubs for ideas, productivity and sources of social development (UN resolution A/RES/71/313) and when functioning properly, cities will inevitably advance both socially and economically.

Besides the UN, global leaders and climate experts also see the potential of setting up science-based goals for urban decision-makers within the IPCC (Intergovernmental Panel on Climate Change) framework. The Summary for Urban Policy makers sheds light on cities as centres for the global population and as economic centres with a key role in ensuring a 1.5°C lower future.

The Urban Agenda, issued by the European Union in 2016, goes further and provides a new multi-level working method promoting cooperation between Member States, cities, the European Commission and other stakeholders. The Agenda places a focus on growth, liveability and innovation within cities for successful ways of addressing social challenges.

Supporting transition, the 'European Green Deal' (Brussels, 11.12.2019 COM(2019) 640 final) approaches another sector and field, setting out its plan is to make EU's economy sustainable. The EU aims to be climate neutral in 2050. A European Climate Law is proposed, in order to turn this political commitment into a legal obligation. The EU will also provide financial support and technical assistance to help those that are most affected by the move towards the green economy (the Just Transition Mechanism). As the EU Biodiversity Strategy for 2030 and the EU Circular Economy Action Plan are at the core of European Green Deal, these documents will be separately reviewed.

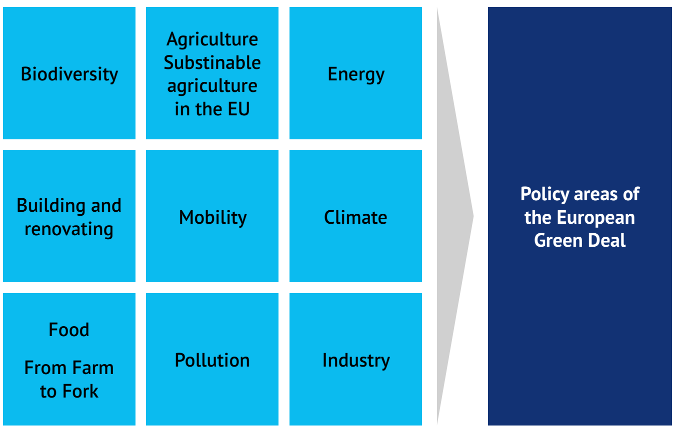

Figure 2.5.1. *Green Deal policy areas.*

2 Analysis of policy documents

The aim of this chapter is to provide a state-of-the-art review of the policy-related aspects of regenerative urban design and development based on the results of recent academic dialogue. It also contains a quick overview of current international policy documents and sets out an investigation of their relevance. A structured analysis of the most relevant policy documents, mostly representing EU regulation and policy dynamics is provided as follows:

1. **Towards a Sustainable Europe by 2030**
   https://ec.europa.eu/info/publications/towards-sustainable-europe-2030_en
2. **A new Circular Economy Action Plan for a Cleaner and More Competitive Europe**
   https://ec.europa.eu/environment/circular-economy/
3. **EU Biodiversity Strategy for 2030 – Bringing nature back into our lives**
   https://ec.europa.eu/commission/presscorner/detail/en/QANDA_20_886
4. **The Urban Agenda for the EU**
   https://ec.europa.eu/futurium/en/urban-agenda
5. **Commission proposal for a regulation: European Climate Law**
   https://ec.europa.eu/clima/policies/eu-climate-action/law_en
6. **Long-term low greenhouse gas emission development strategy of the EU and its Member States**
   https://unfccc.int/documents/210328

Articulating the essence of the aforementioned documents, key policy objectives are gathered together in this chapter, based on the following systematic structure:

> Policy focus
> Time framework
> Policy instruments
> Target group
> Description
> Relevance to scale jumping in urban regeneration

At the end of each document, content highlights, and key implementation details related to regenerative urban design and development are summarized and presented in a text box, calling the reader's attention to the actions needed from stakeholders so that each policy may be successfully implemented.

Towards a Sustainable Europe by 2030.
European Commission (COM(2019) 22 of 30 January 2019)

The document outlines three scenarios on how best to progress towards the Sustainable Development Goals (SDG). It is a part of broader reflection prompted by the White Paper on the Future of Europe, published in March 2017.
Policy focus: Using the UN SDGs, the paper identifies key enablers for the transition towards sustainability.
Time framework: 2019-2030. An implementation process will be set up to monitor progress, setting milestones to be delivered before 2030.
Policy instruments: Promotion of environmental, social and governance standards through trade agreements and multilateral negotiations. Closer cooperation between EU and international organizations. The Commission's proposal for the next multiannual European budget for 2021-2027 is a budget guided by the principles of prosperity, sustainability, solidarity and security. Sustainability is promoted and main-

streamed through numerous programmes and funding instruments: *Neighbourhood, Development and International Cooperation Instrument*, *European Peace Facility*, *InvestEU, Connecting Europe Facility programme*. (EU Budget for the Future)

Target group: Continued mainstreaming of the SDGs in all relevant EU policies by the EC, without enforcing Member States' action. This approach would leave more freedom to Member States, including regional and local authorities when deciding whether and how they can adjust their work to deliver on the SDGs.

Description: This Reflection Paper is a European contribution to the debate on the implementation of SDGs. Besides the EC, valuable inputs are garnered from civil society, the private sector and academia (EU SDG Multi-stakeholder Platform on the SDGs, established by the European Commission in 2017). This document is a part of the broader process for the preparation of the EU's Strategic Agenda 2019-2024.

Relevance to scale jumping in urban regeneration: the "Construction and buildings Sector" is mentioned as one of the policy foundations for a sustainable future, with emphasis on green schools and green campuses. Smart financing for the smart building initiative is one of the potential policy instruments. "Communities" are mentioned in the context of "renewable energy communities" (entities through which citizens and/or local authorities own or participate in the production and/or use of renewable energy), which have been key to triggering the energy transition in Europe. There is no mention of "restorative and regenerative design". The term "restoration" is connected to the ecosystem.

EU Circular Economy Action Plan.
European Commission, Brussels, 11.3.2020. (COM (2020) 98 final)

A new Circular Economy Action Plan for a Cleaner and More Competitive Europe is one of the main blocks of the European Green Deal for the EU.

It is aimed at accelerating the transformational change required by the European Green Deal, while building on circular economy actions implemented since 2015. This plan will ensure that the regulatory framework is streamlined and prepared for a sustainable future and that the new opportunities from the transition are maximized, while minimizing burdens on people and businesses.

Policy focus: The plan consists of a set of interrelated initiatives to establish a strong product policy framework for sustainable products, services and business models, so that they become the norm, transforming consumption patterns and achieving zero-waste outputs in the first place. This product policy framework will be progressively rolled out, while key product value chains (electronics and ICT; batteries and vehicles; packaging; plastics; textiles; construction and buildings; food, water and nutrients) will be addressed as priority matters.

Time framework: Although it is not clearly stated it can be concluded it is for the year 2030 and beyond.

Policy instruments: There are several policy instruments within the Action plan. Within a *sustainable product framework* there are regulatory instruments such as the Ecodesign Directive, as well as specific instruments – Ecolabel and EU green public procurement procedure. EC will propose a sustainable product policy legislative initiative which will widen the Ecodesign Directive beyond energy-related products (and make the Directive applicable to the broadest possible range of products. Within the theme of *empowering consumers and public buyers* there is also the regulatory instrument –EU consumer law- that will be enhanced. Within the *circularity in production process* there is a revision of Industrial Emissions Directive and plan for registering the EU Environmental Technology Verification scheme. As part of its governance of sectoral actions, the EC will cooperate closely with stakeholders in key value chains. The EC will launch a new *Strategy for a Sustainable Built Environment*, to exploit the potential for increasing material efficiency and reducing climate impacts within the construction and building sector. The revision of the Construction Product Regulation is also planned. Developing *digital logbooks for building* is also proposed. Different financing instruments will be implemented in the transition to a circular economy – Cohesion policy fund and the Just transition mechanism (proposed as a part of the European Green Deal Investment Plan and InvestEU), to name only the most relevant.

Target group: The transition to the circular economy will require the cooperation of all stakeholders at all levels – EU, national, regional, local and international, as well as consumers, citizens and civil society organizations.

Description: The EC will exploit the potential of EU financing instruments and funds to support the necessary investments at regional level and ensure that all regions benefit from the transition to a circular economy. Circular economy solutions will be tailored to the outermost regions and islands, due to their dependence on resource imports, high waste generation fuelled by tourism, and waste exports.

Circularity is seen as a prerequisite for climate neutrality. *Construction and buildings* is one of the 7 key product value chains. It is identified as a sector with significant impact on many sectors of the economy, on local employment and quality of life. In addition, its environmental impact is enormous in terms of greenhouse gas emissions, resource consumption and waste generation. The term "regenerative" is mentioned in the context of growth model.

EU Biodiversity Strategy for 2030 – Bringing nature back into our lives; May 2020. European Commission, Brussels, 20.5.2020 (COM(2020) 380 final)

The EU Biodiversity Strategy is a comprehensive and long-term plan for protecting nature and reversing the degradation of ecosystems. It is also the proposal for a European contribution to the international negotiations on the global post-2020 biodiversity framework. It is the central part of the European Green Deal.

Policy focus: Biodiversity and protected areas on land and at sea.

Time framework: By 2030.

Policy instruments: There are diverse policy instruments ranging from regulatory to financial (Renewed Sustainable Finance Strategy). An EU Nature Restoration Plan is proposed to restore ecosystems across the EU. There is a set of measures including a governance framework to ensure better implementation, monitor progress, improved knowledge, financing and investment and more respectful attitudes towards nature in public and business decision-making. The European Commission is calling on European cities of at least 20,000 inhabitants to develop ambitious Urban Greening Plans by the end of 2021 that will bring nature back to our cities and reward community action.

These should include measures to create biodiverse and accessible urban forests, parks and gardens; urban farms; green roofs and walls; tree-lined streets; urban meadows; and urban hedges.

Target group: Biodiversity is a priority of the EU's external action and an integral part of efforts to meet the United Nations SDGs. It will be mainstreamed throughout bilateral and multilateral engagements, through the EU's "Green Deal diplomacy", and forthcoming green alliances. The Commission will work closely with the European Parliament and Member States. Every Member State will have to shoulder its fair share of the effort based on objective ecological criteria, recognizing that each country has a different quantity and quality of biodiversity. Success stories:

Nature-based solutions such as protecting biodiversity and restoring ecosystems are an excellent means of countering the effects of climate change and a very cost-effective use of resources. Restoring forests, soils and wetlands and creating green spaces in cities are essential to achieve the goals for climate change mitigation by 2030.

The promotion of healthy ecosystems, green infrastructure and nature-based solutions should be systematically integrated into urban planning, and included in the design of buildings, public spaces and infrastructure.

Green urban spaces, from parks and gardens to green roofs and urban farms, provide a wide range of benefits for people. They also provide opportunities for businesses and a refuge for nature. They reduce air, water and noise pollution, provide protection from flooding, droughts and heat waves, and maintain a connection between humans and nature.
The terms "Restorative/regenerative design" are only mentioned in the context of the ecosystem and nature.

The Urban Agenda for the EU

Cities in Europe are at the heart of many of today's economic, environmental and social challenges. **The urban agenda for the EU launched in May 2016** is pivotal in ensuring that urban areas act as catalysts for innovative sustainable solutions, promoting the transition to low-carbon and resilient societies. The urban agenda for the EU is a joint effort of the Commission, Member States and European cities, to ensure better consideration of the impact of urban-area policies. It also aims to strengthen the resilience of urban settings by preventing disasters and climate related risks. The urban agenda for the EU is reinforced by Commission initiatives, such as the Covenant of Mayors, that promote long-term energy and climate action at a local level.
Policy focus: It focuses on 3 pillars of policy-making and implementation: better regulation, better funding and better knowledge.
Policy instruments: Thematic partnerships represent various governmental levels and stakeholders are the key delivery mechanism within the Urban Agenda for the EU. There are pilot partnerships: "Amsterdam partnerships" – inclusion of migrants and refugees, affordable housing, air quality and urban poverty; "Bratislava partnerships" – circular economy, digital transition, jobs and skills in the local economy, urban mobility; "Malta partnerships" – climate adaptation, energy transition, responsible and innovative public procurement; sustainable use of land and nature-based solutions.
Thematic partnership is informal multi-level collaboration connecting cities, member states and EU Commission stakeholders. It works on priority themes towards better regulation, better funding and better knowledge sharing. There is a 3-year mandate to draft the action plan and for its implementation. Progress reports are submitted to the Council (Urban Development Group and DG meeting on Urban Matters).
The "Malta" partnerships were launched in July 2017 with the following priority themes: climate adaptation, energy transition, public procurement and sustainable use of land and nature-based solutions.
Climate Adaptation is one of the priority themes to be addressed by the Urban Agenda. The action plan was adopted in October 2018. It provides concrete proposals for future designs and the revision of existing EU legislation, instruments and initiatives relating to adaptation to climate change in urban areas within the EU.

The Partnership on energy transition presented its final Action Plan in May 2019. The Plan proposes 5 actions for energy transition within Europe: financing for district energy task groups; maximizing use of wasted heat in cities; guidance on energy master planning for cities; deployment desks for city retrofitting; closer cooperation with EU bodies to promote energy transition funding.
(https://ec.europa.eu/futurium/en/system/files/ged/uaetp_final_action_plan.pdf)

The Partnership on Innovative and Responsible Public Procurement presented its final Action Plan in October 2018. The Partnership formalized seven Actions: Guidance on building city strategic procurement and ways of managing strategic procurement; Measuring expenditure and wider impact in European cities; Recommendations for funding for procurement of innovation, strategic procurement, joint cross-bor-

der procurement and in particular social procurement and circular procurement; Innovation procurement brokerage; Legal handbook innovative public procurement;
A flexible concept for setting up and further development of Local Competence Centres for innovative and sustainable procurement and Competence building in circular procurement.
(https://ec.europa.eu/futurium/en/system/files/ged/final_action_plan_public_procurement_2018.pdf)

The Partnership on Sustainable Use of Land and Nature-based Solutions was presented in October 2018. There are 9 actions to help create compact, liveable and inclusive European cities: including land take and soil properties in impact assessment procedures; a funding and financing guide for brownfield redevelopment; identifying and managing under-used land; indicators of land take; promoting Functional Urban Areas (FUA) cooperation as a tool to mitigate urban sprawl; better regulation to boost NBS at European, national and local levels; better financing for NBS; awareness raising in the areas of NBS and the sustainable use of land; agreeing on common targets and indicators for NBS, urban green infrastructure, biodiversity and ecosystem services in cities.
(https://ec.europa.eu/futurium/en/system/files/ged/sul-nbs_finalactionplan_2018.pdf)

Establishing the framework for achieving climate neutrality and amending regulation. (EU) 2018/1999 (European Climate Law)

Target group: EU, national and local levels including stakeholders such as businesses, experts and NGOs.
Topic/Policy focus: Establish the framework for achieving EU climate neutrality,
Time framework: By 2050
Location/Scale: European Union
Level: European level and, where possible, at global level
Policy instruments/measures: Regulation, EU law
Target groups: Policymaker, business, workers, investors, consumers, citizens
Dominant instruments/measures: The objectives of the long-term 2050 climate-neutrality can best be translated into legislative regulations to ensure its direct implementation. At State level, Member States can contribute to achieving climate-neutrality based on the requirements directly imposed by the Commission using such measures as assessment, reporting, recommendations, additional measures and review. It will ease pressure on the European Environment Agency that is implementing the requirement at national level and will ensure the applicability of the provisions.
At Commission level, instruments and measures will be carried out at EU level such as reviewing the 2030 target and related policy instruments, setting a trajectory, assessment of consistency of the existing policy framework, a five-yearly assessment, issuing recommendations and additional measures.
Description: This framework enhances certainty and confidence surrounding EU commitments towards the industry including businesses, workers, investors and consumers. It therefore maintains the prosperity of job opportunities, as it points to a clear path towards achieving climate-neutrality, transparency and accountability.
The financial model adopted by this proposal includes the European Green Deal Initiative, the European Green Deal Investment Plan (COM (2020) 21 final of 14 January 2020) and the proposal for a Regulation establishing the Just Transition Fund (Proposal for a Regulation of the European Parliament and of the Council establishing the Just Transition Fund, COM (2020) 22 final). Other initiatives which are under preparation include the EU strategy on Adaptation to Climate Change that also supports the same objectives.
This proposal interacts with various policy themes and existing instruments as it enshrines the EU's 2050 climate-neutrality objective in the legislation, in line with scientific findings reported by the IPCC and the

Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES) (Commission Communication - The European Green Deal, COM(2019) 640 final of 11 December 2019). The proposal also contributes to implementation of the Paris Agreement on climate change and Sustainable Development Goals (Article 2.1.a of the Paris Agreement). It charges the Commission with a task to examine consistency with the objectives of climate-neutrality by reviewing policies and Union legislation up until 2050.
A robust governance system was established, in order to ensure that the EU will achieve the objectives of climate-neutrality by 2050. At EU level, actions on climate change adaptation have promoted the integration of EU policies and measures within key sectors and at all levels of governance.
During the preparation for the 'Clean Planet for All' (Annex 7.1 to the In-depth analysis in support of the Commission Communication COM (2018) 773), significant support was found both from organizations and individuals during the public consultation. There was a comprehensive debate among Member States, institutions, local and regional authorities, social partners, businesses, industry, stakeholders and the citizens when the 'Clean Planet for All' Communication was adopted.
A four-week feedback period was opened from 9 January 2020 to 6 February 2020 while a roadmap on the initiative was published by the Commission. 926 pieces of feedback were received from stakeholders and contributors including many European and national associations representing industrial sectors such as the power, automotive and steel sectors, as well as private companies, NGOs and many EU citizens. Public authorities from seven Member States (Denmark, France, Germany, Portugal, Spain, Sweden and The Netherlands) and Norway contributed to the consultation process.

Long-term low greenhouse gas emission development strategy of the EU and its Member States

Topic/Policy focus: Long-term low greenhouse gas emission, a climate-neutral EU
Time framework: By 2050
Location/Scale: European Union and its Member States
Level: EU (Continent)
Policy instruments/measures: Detailed analysis of solutions based on Strategic long-term vision
Target groups: Policymaker, citizen, (indirectly on) designers, urban planners, building equipment and service vendors, building users
Dominant instruments/measures: Effective measures were developed in this document to deal with carbon leakage in a way that is compatible the World Trade Organization (WTO). A carbon border adjustment mechanism concerning carbon-intensive sectors, is proposed. For the building sector, options to approach long-term reductions of energy use and associated CO_2 emissions include:

> Energy performance of the building shell/ U-value
> Efficient equipment/ Efficiency, CoP (Coefficient of performance)
> Fuel switch in heating and cooling (renewable source: solar thermal, geothermal, biomass boilers and ambient energy). Efficiency depends on which renewable source is adopted and how they are combined.
> Smart buildings/ Grid connection, Energy optimization, indoor parameters management, comfort and well-being, smart charging, etc.
> Nearly zero-energy buildings/ Combining instruments mentioned above
> Societal and consumer choices/ Indoor temperature control, sharing of appliance, urban planning for short commuting

Description: This document reiterates the full commitment of the EU and its Member States to the Paris Agreement and its long-term goals. The European Council, taking note of the communication of the European Commission on the European Green deal, endorsed the objective for achieving a climate-neutral EU

by 2050, in accordance with the United Nations Framework Convention on Climate Change (UNFCCC) and Article 4.19 of the Paris Agreement.
Forward-looking research, development and innovative policies are important to stimulate the potential for economic growth, new business models and markets and new jobs through technological development. In the building sector, the Energy Performance of Buildings Directive (EPBD) and the Energy Efficiency Directive (EED) proposed a robust regulatory basis and incentives to build low carbon-emission buildings. As there is no sunset clause on energy efficiency obligations, the robust base will spur building renovations even beyond 2030. Furthermore, consumers pay more attention to their choices over the energy consumption of appliances and buildings due to the spur of EU energy labelling and eco-design rules. Industry is also urged to improve the industrial design of businesses and strategic product development.
Significant investment from public and private sectors will be required for the transition. In this context, the European Investment Bank (EIB) intends to support investment of EUR 1 trillion in climate action and environmental sustainability from 2021 to 2030. It highlights that climate action will be significantly addressed by the next Multiannual Financial Framework (MFF).
The InvestEU programme, which is one of the EU financial instruments currently available to support investments in the EU, plays an important function by leveraging private investments for the transition. Tailored support will be available to regions and sectors which are most affected by the transition, from the forthcoming Just Transition Mechanism (JTM). The announcement by European Commission that a total of EUR 100 billion of investment will be allocated through the Just Transition Mechanism was welcomed by the European Council. Funding for transformation efforts are set to continue after 2030.
Acknowledging the need for energy security, the European Council respects the interest of its Member States to determine the most appropriate energy source composition and technologies at the country level. The EU shows its global leading position by taking action to reach climate-neutrality by 2050. The Commission is invited by the European Council to examine the feasibility of existing rules which includes state aid and public procurement.

3 Sharing Best Practices on Urban Policy Implementation

Construction Products Regulation (CPR) EU305:2011 promoting Green Composite-Façades

In 2011 the EU revised the Construction Products Directive as Regulation EU305:2011. In addition to the traditional requirements, it now also demands the maximum possible use of renewable resources in construction materials. So-called Wood-Plastic Composites (WPC) represent these new types of biobased recyclable materials. They consist of a petrochemical thermoplastic matrix incorporating as much as 80% wood fibre. As extruded façade panels, they are almost CO_2-neutral and can be recycled into new panels at the end of their useful life (Friedrich, 2018).

Figure 2.5.2. *WPC Façade Panels (www.upm.com)*

Compliance with the requirements of the CPR is voluntary. Nevertheless, it is not without effect, because product manufacturers are under greater pressure than ever to offer more sustainable products. Decision-makers are also increasingly seeking to build up a green image and even private consumers are showing more interest in biobased building products. A high proportion of wood fibre in the façade is not only climate-friendly, but is also used to optimize thermal insulation of buildings, saving on energy costs and offering a pre-fitted façade that insulates against sound (Friedrich, 2020). In addition, the combination of wood fibre with a thermoplastic matrix offers ideal conditions for effective material recycling. Even though these façades have a shorter lifespan, production below a maximum extrusion temperature of 200°C requires comparatively less energy and therefore justifies earlier renewal of façades. Under shorter trends for colour and geometry, their use becomes more efficient for private house owners.
This life-cycle concept can be consistently implemented at neighbourhood level. Wood fibres can be sourced from regional forests and are a waste product from local sawmills. Façade profiles can be extruded from compounded WPC in contract manufacturing by local plastics processing companies. The installation and dismantling of the old WPC façade is carried out by local contractors. The panels can be easily granulated and remanufactured by remelting with the addition of colour pigments and additives to create new façades. The neighbourhood will virtually get back its old façade, but with a new design and refreshed mechanical properties (Friedrich, 2015).
The CPR is therefore not only a set of rules, but also stimulates the holistic thinking of all those involved in construction. It not before time that the Building Products Regulation is now also focused on the origin and destination of resources.

Syn.ikia – Plus Energy Neighbourhoods

When considering carbon neutrality, both energy and the building sector are key to a green and just transition. According to the International Energy Agency (IEA, 2019), buildings represent 30% of global final energy consumption and 28% of energy-related GHG emissions worldwide.
Syn.ikia is addressing the problem by initiating an innovation project within the EU Horizon 2020 and has collaborated with 13 partners from six countries representing different climates, contexts and markets across Europe. During the four-year project (2020-2024), four plus-energy demo neighbourhood projects are planned for development and will represent four different climatic zones.
While the main contribution of a **Positive Energy Building relates to its energy production** as it can overrun its renewable energy consumption over one year, when accounted for at source, in a **Sustainable Plus Energy Neighbourhood**, the geographical boundary will cover the entire site of the neighbourhood, including Local Storage and Energy Supply Units. In this case, users, buildings and technical systems are interwoven via the neighbourhood digital cloud (HUB).

Sustainable Plus Energy Neighbourhoods includes the following focus areas:
> Cost efficiency
> Indoor environmental quality
> Occupant satisfaction
> Social factors: co-use, shared services and infrastructure
> Power performance: peak saving, flexibility, self-consumption
> Greenhouse gas emissions

A large-scale implementation of Sustainable Plus Energy Neighbourhoods will be demonstrated at different levels:

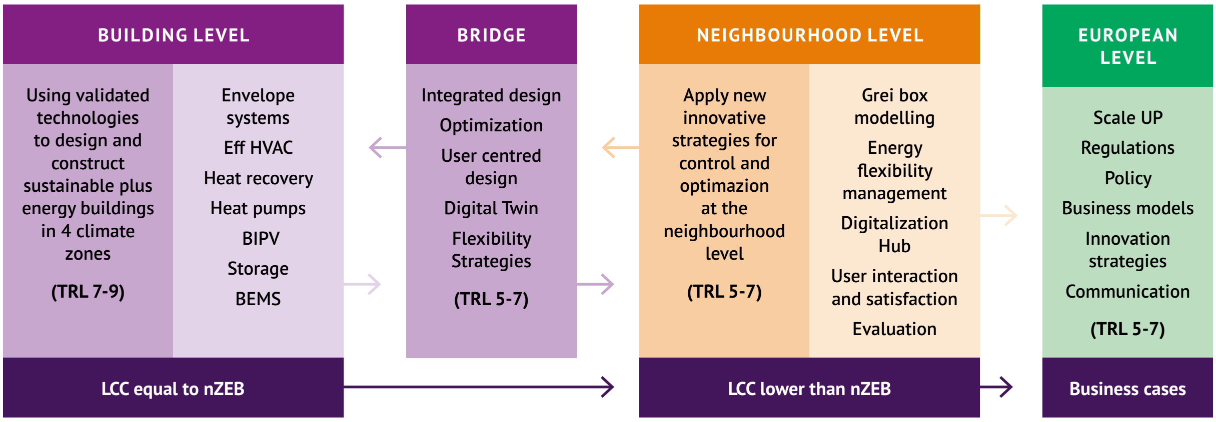

Figure 2.5.3. *Synika methodology (www.synikia.eu).*

A very important connection with the European energy efficiency initiatives (EPBD – Energy Performance of Buildings Directive) is that the project will operate with different solutions for coherence with strategies and policy papers.

4 Conclusions

A policy coherence approach could be very useful for implementing EU policy documents. It is a policy tool for integrating economic, social, environmental and governance issues of sustainable development to all phases of policy making.
The 2030 Agenda (A/RES/70/1) requires a transition from policy coherence for development (PCD) to Policy Coherence for Sustainable Development (PCSD). Enhancing policy coherence is a challenge of international development and effective governance. PCD includes political commitment, horizontal and vertical policy coordination as well as monitoring systems. After more than 20 years of promoting PCD, it is obviously insufficient and something more is needed. The new PCSD incorporates the following mechanism to ensure coherence: fully engagement of all levels of government; capacity to manage diverse interactions of sectoral policies; participation of key stakeholders; and implementing the capacity for strengthening monitoring and reporting systems. Green growth policies are expected to play an essential role in the integration of sustainability dimensions into policy making. The PCSD has to move beyond a "do-no-harm" approach to a partnership approach based on win-win solutions. It is important to stress that the 2030 Agenda attempts to move beyond the single-goal vision and will instead incorporate many diverse targets within the idea of human well-being.
In a similar way to the 2030 Agenda, the EU Circular Economy Action Plan and the EU Biodiversity Strategy for 2030 (COM (2020) 98 final) also require policy coherence for sustainable development. In general, it can be said that all EU states at a national level ensure vertical and horizontal coherence and provide various sources of financial incentives when implementing green policies. Evaluating and monitoring progress towards green growth will certainly require more efforts in the future. A potential threat is found here in so far as countries are more willing to analyze coherence than to analyze the real impacts of their policies.
During the sessions of the RESTORE community's Legislation and policy subgroup, several keywords were identified: construction and building, communities, restoration/regeneration, restorative/regenerative design, scale-jumping:

- The Document Towards a Sustainable Europe by 2030 contains “construction and building” terms and emphasizes the importance of green school and campuses. There is also a mention of “energy communities” while “restoration” is mentioned in relation to ecosystem.
- EU Circular Economy Action Plan is a very comprehensive document and it also contains references to “construction and building” as one of 7 key value product chains. The “Regenerative growth model” is seen as a model that will foster the transition to a circular economy. The issue of “scale-jumping” is briefly mentioned in the context of a “transition from front-runners to the mainstream economic players”, and it is not mentioned in the context of construction and building sector.
- The EU Biodiversity Strategy for 2030 is focused on a biodiversity and land/sea protected areas. The keywords are not identified in the document, except for “restoration/regeneration” of the ecosystem.

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Links to policy documents and reports

Towards A Sustainable Europe by 2030

Reflection paper Towards a Sustainable Europe by 2030

https://ec.europa.eu/commission/sites/beta-political/files/rp_sustainable_europe_30-01_en_web.pdf

Europe moving towards a sustainable future - Contribution of the SDG Multi-Stakeholder Platform to the Reflection Paper “Towards a sustainable Europe by 2030”, October 2018

https://ec.europa.eu/info/sites/info/files/sdg_multistakeholder_platform_input_to_reflection_paper_sustainable_europe2.pdf

A European Green Deal

Policy area	Documents
Biodiversity	Communication: EU Biodiversity Strategy for 2030 - Bringing nature back into our lives; May 2020; https://eur-lex.europa.eu/legal-content/EN/TXT/?qid=1590574123338&uri=CELEX%3A52020DC0380
	Factsheet: EU Biodiversity strategy 2030; May 2020; https://ec.europa.eu/commission/presscorner/detail/en/fs_20_906
	Factsheet: the business case for biodiversity; May 2020; https://ec.europa.eu/commission/presscorner/detail/en/fs_20_907
Food – From Farm to Fork	Communication: A Farm to Fork Strategy for a fair, healthy and environmentally-friendly food system; May 2020; https://eur-lex.europa.eu/legal-content/EN/TXT/?qid=1590404602495&uri=CELEX%3A52020DC0381
	Factsheet: From farm to fork: Our food, our health, our planet, our future; May 2020; https://ec.europa.eu/commission/presscorner/detail/en/fs_20_908
Agriculture – Sustainable agriculture in the EU	The CAP reform's compatibility with the Green Deal's ambition; May 2020;
	https://ec.europa.eu/info/sites/info/files/food-farming-fisheries/sustainability_and_natural_resources/documents/analysis-of-links-between-cap-and-green-deal_en.pdf
	How the CAP contributes to the Green Deal; May 2020; https://ec.europa.eu/info/sites/info/files/food-farming-fisheries/sustainability_and_natural_resources/documents/factsheet-how-cap-contributes-to-green-deal_en.pdf
Energy	Clean energy; December 2019; https://ec.europa.eu/commission/presscorner/detail/en/fs_19_6723
	Factsheet: EU Energy System Integration Strategy; July 2020; https://ec.europa.eu/commission/presscorner/detail/en/fs_20_1295
	Factsheet: A Hydrogen Strategy for a Climate Neutral Europe; July 2020; https://ec.europa.eu/commission/presscorner/detail/en/fs_20_1296
	Factsheet: European Clean Hydrogen Alliance; July 2020; https://ec.europa.eu/commission/presscorner/detail/en/fs_20_1297
Industry	Sustainable industry; December 2019; https://ec.europa.eu/commission/presscorner/detail/en/fs_19_6724
Building and renovating	Building and renovating; December 2019; https://ec.europa.eu/commission/presscorner/detail/en/fs_19_6725
Mobility	Sustainable mobility; December 2019; https://ec.europa.eu/commission/presscorner/detail/en/fs_19_6726
Pollution	Eliminating pollution; December 2019; https://ec.europa.eu/commission/presscorner/detail/en/fs_19_6729
Climate	EU Climate action and the European Green Deal; https://ec.europa.eu/clima/policies/eu-climate-action_en
	European Climate Law; March 2020; https://ec.europa.eu/clima/policies/eu-climate-action/law_en

The Just Transition Mechanism: making sure no one is left behind

https://ec.europa.eu/info/strategy/priorities-2019-2024/european-green-deal/actions-being-taken-eu/just-transition-mechanism_en

EU Circular Economy Action Plan

Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions – A new Circular Economy Action Plan for a Cleaner and more Competitive Europe

https://eur-lex.europa.eu/legal-content/EN/TXT/DOC/?uri=CELEX:52020DC0098&from=EN

From Construction 2020 to a new vision for a sustainable built environment

https://ec.europa.eu/transparency/regexpert/index.cfm?do=groupDetail.groupMeetingDoc&docid=35639

EU Biodiversity Strategy For 2030

EU Biodiversity Strategy – factsheet:

https://ec.europa.eu/info/sites/info/files/env-20-002_factsheet1-vbo-en-b.pdf

The EU's 2030 Biodiversity Strategy:

https://europa.eu/!uc64jT

The Urban Agenda for the EU

The urban agenda for the EU: https://ec.europa.eu/futurium/en/node/1829#One-Stop-Shop

The European Commission has launched a city portal on the Europa website in October 2016, which will work as a one-stop-shop guiding all interested actors through the different policies and instruments in place; https://ec.europa.eu/info/eu-regional-and-urban-development/cities

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Credits: Adobe Stock / chekman

3. Practice Exercise

Collage: Jelena Brajkovic.
Images: Rosa Valentina Martino, Carlo Battisti, David Calas
Map data: Google, ©2020 / Brigittasquare aerial view, Vienna

3

JUMP 2030 – “The Good Urban Life”

A Holistic Vision for the Brigittaplatz/Hannovermarkt in the 20th district of Vienna

Vienna Training School and Online Conference

Vienna (Austria) 21st - 25th September 2020

TABLE OF CONTENTS

JUMP 2030 - “The Good Urban Life”

1 Vienna Training School and Online Conference

Vienna

Vienna, for the 10th time in a row elected as the most liveable city in the world and European ‘capital’ of social housing, appears to have all the ingredients of a successful urban environment. Despite these awards, the city is locked in a continuous struggle for general liveability, affordable housing and acceptable implementations of smart technologies. These approaches are carried out against the background of sensational news, relying on bold decisions, political facilitation and holistic planning. Approaches that refer to broad-ranging fields, from circularity to socio-cultural reflections, which define our urban environments, were discussed at the Viennese training school (TS) in September: ‘Jump 2030 – The Good Urban Life’.

Aim of TS

The aim of the TS is the implementation of a holistic vision, a systems-thinking approach that applies regenerative sustainable design principles to an existing Viennese neighbourhood. The challenge is to find a strategy that considers so called ‘Jumps’ which range from the district level to the in-between gaps. Interdisciplinary group work and a strong relation to the socio-cultural spirit of the district in general are the framework of the TS topic JUMP 2030 – ‘The Good Urban Life’.

‘The Good Urban Life’

The research and design project will represent an opportunity for enhancing ‘The Good Urban Life’ in all its manifestations. Socio-cultural aspects, governance considerations and potential implementation scenarios, are enlarging the design approach of this TS. Approaches, which were discussed in morning input sessions, admired during site visits at Nordbahnhof, Nordwestbahnhof, Seestadt Aspern and the IBA Vienna exhibition, trainees integrated into their afternoon sessions.

Brigittaplatz/Hannovermarkt, the Site

The aim of the TS was to learn from good urban Viennese practices (Nordbahnhof Gelände, Nordwestbahnhof), by focusing on a less commonly considered, but no less important part of town - a part of the 20th Viennese district, where three centuries of planning credos, from the time of the ‘Gründerzeit’ (Urban expansion during the industrial revolution) to ‘Ribbon Developments’ and finally to the current mobility issues, are merging together. The latter refers to the Brigittaplatz together with the nearby Hannovermarkt (local market) where a unique test plot for future urban scenarios on different scales is offered.
It was only in the course of its industrialisation in the 19th century when the Brigittaviertel was developed over a larger area, whereby the Grätzel (Viennese for quarter/neighbourhood) became established as a productive/workshop location, due to the low cost of land and its location near a water course - Donaukanal.

The industrial history reflected the settlement of machine factories, leather factories, factories for the production of steam rollers, light bulb factories, etc. Linked to this process a narrative of a neighbourhood of 'workers' and 'migrants' developed and has persisted up until today.
During the Second World War, as it was a manufacturing site, the Brigitta Quarter was badly hit by bombing, and the Hannovermarkt was destroyed. In addition to the redevelopment of the Hannovermarkt with a uniform stand configuration, the linear development on Brigittaplatz, which is linked to urban modernism and a belief in modernization, originated in the 1960s.
The structural heterogeneity that developed over time is also reflected to a certain extent in the social structure, which in turn has a socio-spatial effect on the public space and the entire part of this district. The site can be characterized as heterogeneous and polycentric with a larger structural spaciousness.
From a socio-historical point of view, a conscious approach to the history of the Grätzel might be relevant, in which the migrant and proletarian tradition is a characteristic feature. This heritage should also be reflected in the recently developed understanding of appropriation and participation - possibly differentiated from an (educational) bourgeois image of the design and use of public space. A big challenge in terms of projected developments that needs to addressed in future planning scenarios.

Figure 3.1. *Map data: Google, ©2020 / Brigittasquare aerial view, Vienna*

Afterlife & Dissemination

The work of the Training School (TS), the results and findings will be considered and used as input by the City of Vienna for the recently established 'DoTank Circular City 2020-2030' (DTCC30) multi-stakeholder platform. The aim of this platform is to make the idea of a Circular Economy under the umbrella of the City´s Executive Group for Construction and Technology a tangible reality on the ground. Promoted by the EGCT Executive Group for Construction and Technology, City of Vienna, additional publications are foreseen.

In cooperation with Studio Calas (urban planning, architecture, socio-cultural approaches and participatory action) and the City of Vienna, additional analysis, research and implementation of goals and strategies developed within the TS are planned, in the form of the COST RESTORE Short Term Scientific Mission, which is planned to be held in Vienna under the direction of Dr. Jelena Brajkovic, and the supervision of Dr. David Calas and Dr. Anna-Vera Deinhammer.

People

Scientific committee

Jelena Brajković (University of Belgrade, Faculty of Architecture), David Calas (Studio Calas, Vienna/German University Cairo, Berlin), Anna-Vera Deinhammer (City of Vienna, Executive Group for Construction and Technology), Andreas Reith (ABUD, Budapest), Marcello Turrini (Marcello Turrini ZT, Vienna)

International Trainers

Jelena Brajković (University of Belgrade, Faculty of Architecture), Viktor Bukovszki (ABUD, Budapest), and Emanuele Naboni (The Royal Danish Academy, School of Architecture, Denmark).

Local Trainers

David Calas (Studio Calas/GUC), Anna-Vera Deinhammer (City of Vienna, Executive Group for Construction and Technology), and Marcello Turrini (Marcello Turrini ZT).

Trainees

Sagnik Bhattacharjee (Czech Republic – Architecture & Urban Design), Luca Caruso (Italy - Architecture & Urban Design), Julia Flasnynska (Austria - Circular Economy), Qingchang He (Hungary - Landscape Design), Clemens Horvath (Austria - Architecture & Urban Design), Tudor Iuga (Romania - Mobility Design), Wlada Kijewska (Poland - Architecture & Urban Design), Rosa Martino (Austria - Social Design), Doriana Matraku (Albania - Social Design), Barbara Mayr (Austria - Landscape Design), Marian Ontkoc (Slovakia - Social Design), Indra Purs (Latvia - Landscape Design), Tania Rus (Romania - Circular Economy), Silvia Vian (UK - Architecture & Urban Design), and Alejandra Vidales (Spain - Circular Economy)

Keynotes

Carlo Battisti (EURAC Research, Living Community Challenge), Martin Brown (Fairsnape, Sustainability Provocateur), David Calas (Studio Calas/GUC), Anna-Vera Deinhammer (City of Vienna, Executive Group for Construction and Technology), Michael Fürst, Paul Schulz (Team Vivi House, IBA Vienna), Julia Girardi-Hoog (smarter together, City of Vienna), Roman Grünner (Deep Demonstration Vienna-Climate KIC), Daiva Jakutyte-Walangitang (AIT, Research Engineer, Sustainable Buildings and Cities), Dorota Kamrowska-Zaluska (Gdansk University of Technology), Johannes Kisser (alchemia nova, Vienna), Christian Knapp (KLK Office), Roland Krebs (superwien, Placemaking Europe), Stefan Melzer (MO. Point, Vienna), Haris Piplas (Dr. ETH Zürich, Drees & Sommer Schweiz), David Tudiwer (Executive Office for Building Affairs and Technology, City of Vienna), and Maria Vassilakou (Former Vice Mayor of Vienna, member of the Mission Board Horizon Europe).

Jury

Christian Knapp (KLK Office), Bernadette Luger (Urban Innovation Vienna), Nikolas Neubert (AIT, Head Urban Digital Resilient Cities), Haris Piplas (Dr. ETH Zürich, Drees & Sommer Schweiz), Andras Reith (ABUD, Budapest), and Karin Stieldorf (TU Vienna, Institute of Architecture).

TS coordinator

Dorin Beu (Green Building Council President, Romania).

2 JUMP 2030 Framework & Methodology

> Forward-looking visions build upon a historical-social planning bases (provided by the walks/keynotes/ trainers), think in a present-day context and shape through multidisciplinary design approaches as well as researching an image of 'The Good Urban Life'.
> Governance, urban planning visions and holistic design approaches are the key-performance-indicators (KPI) of this TS 'Jump 2030'. Therefore, broad-ranging strategies are required to address current urban issues on the example of Vienna/Brigittaplatz-Hannovermarkt. The TS aims to assemble multidisciplinary groups, learning together, which increases the chance to create holistic visions.
> Through a link of socio-cultural, space-shaping and technology-driven approaches, the following questions have been addressed:
> How is 'the good life' currently perceived within urban spaces from a planning viewpoint?
> How is designed space/technology influencing the liveability of cities and well-being?
> How can socio-cultural strategies enhance urban life?
> Which role will urban space have in a political context?
> The design-oriented but research-driven involvement with the topic follows a flexible frame, allowing participants to acquire a strong grounding through interdisciplinary exercises as well as a trans-disciplinary study/result.
> Merging methods between Socio-Cultural Sensitive Planning, Circularity, Performance and Biophilia, created the necessary autonomy to deal with the given plot and scale jump.
> Furthermore, TS-participants are enabled to formulate their own design investigations, by accomplishing autonomous driven approaches and expressing an individual (group-related) vision. Trainees were selected according to their professional training and achievements, in order to ensure a multidisciplinary team constellation. Therefore, Urban Design & Architecture, Circular Design, Landscape Design, Social Design & Socio-Cultural Sensitive Planning and Mobility Design positions were merged following a common, team-driven goal.

Co-benefits and Scale Jumping Strategies

Contribution by Prof. Emanuele Naboni, PhD

Co-benefits are conducive to the sharing of assets in a creative, elegant and efficient design "move" that leads to energy flows, natural flows, living districts, and people capable of reaching a cooperative status. This type of approach is the opposite of the one pursued by a single purposed sustainable strategy that is dealing with one topic at the time. The scope is, therefore, to imagine, develop and simulate the performance of a built environment that is as connected as a forest ecosystem.

The achievement of co-benefits implies the creation of a new set of relationships that reinforce the state of health of natural ecosystems and humans, utilizing appropriate and creative design strategies, construction and technology. This challenge implies an in-depth knowledge of multiple fields, and the involvement therefore of several specialists. Furthermore, suitable parametric simulation tools and frameworks for integrated approaches and solutions need to be developed.

Scale Jumping permits single/multiple building components, building/s, space/s, district/s and cities to systematically connect to ecosystem services and infrastructure to operate in a cooperative state. In brief, scale jumping implies selecting scales and understanding which scale is the most effective for reaching a given regenerative target.

Ideally, projects generate their energy, capture their water, and process their waste. Yet, the ideal scale for solutions is not always within a project's boundary. Depending on the type of performance and the design strategy or technology, the optimal scale can vary when considering environmental impact, initial costs, operating costs and co-benefits across scenarios. To address these realities, projects must pursue scale jumping overlay to allow multiple components, buildings, spaces or projects to act in a cooperative state—sharing green infrastructure as appropriate and allowing for environmental and social benefits to be achieved as elegantly and efficiently as possible. Designing with city, district, local, buildings and nano scales in mind certainly challenges designers to embrace forward-thinking and multidisciplinary knowledge.

3 Key-Note Topics and Lectures during the Online Conference

(In order of scheduled appearance)

David Calas (Studio Calas/GUC)

David Calas, architect, urbanist, critic and curator is founder of STUDIO CALAS, including the role as lecturer at the Technical University of Vienna – Faculty of Architecture, Austria and Guest professor at the German University Cairo/Campus Berlin, Germany.

Keynote: Welcome Address/Starting Points for a Post COVID City

Carlo Battisti (EURAC Research, Living Community Challenge)

Co-founder of the Living Future Italy Collaborative and since 2018 European Executive Director for the International Living Future Institute and now President of Living Future Europe. Chair and Project Manager of the COST Action 16114 RESTORE since 2017 at EURAC research.

Keynote: It's time to create a Living Future. It's time for Scale Jumping.

Roland Krebs (superwien, Placemaking Europe)

Austrian urban planner and urbanist, develops strategic action plans for cities to tackle urban growth. Roland is a lecturer at the Institute of Urban Design and Landscape Architecture at the TU Wien and co-founder of the urbanism and architecture practice 'Superwien urbanism ZT OG'. Keynote: How can we create thriving cities and great places?

Anna-Vera Deinhammer (City of Vienna, Executive Group for Construction and Technology)

Founder and leader of "DoTank Circular City 2020-2030" in Vienna. Her research and practical work has always dealt with providing a healthy, liveable, healthy built environment. In her work, she aims to combine the best of two worlds: the academic world and the construction industry, fostering an integrated approach.

Keynote: DoTank Circular City 2020-2030.

Christian Knapp (KLK Office)
Christian Knapp is the co- founder of BÜRO KLK, a planning office based in Vienna. His work relates to URBANAUTS GmbH, providing lifestyle accommodations in formerly abandoned shops on Vienna's ground floor, as well as Kreative Räume Wien GmbH the Viennese agency for activation of urban vacancy and temporary use.
Keynote: Working on Scale Jumps.

Martin Brown (Fairsnape, Sustainability Provocateur)
Martin Brown is an innovative sustainability 'provocateur', advocate and business improvement consultant at Fairsnape practice, based in the Forest of Bowland, Lancashire, UK.
Keynote: Futurestorative.

Daiva Jakutyte-Walangitang (AIT, Research Engineer, Sustainable Buildings and Cities)
Urbanism, spatial planning and urban and architectural design are the fields of expertise in which Daiva has gained twenty years of international experience. Before occupying project manager position at the AIT, Energy Center in May 2011, she has worked in Dublin/Ireland, Boston/United States and Frankfurt am Main/Germany on urban planning, urban design and development and architectural implementation projects.
Keynote: Tapping the Potentials of Integrated Urban Planning.

Dorota Kamrowska-Zaluska (Gdansk University of Technology)
Assistant Professor and Director of mid-career program on Urban development and management of metropolitan areas, at the Department of Urban Design and Regional Planning at Faculty of Architecture, Gdansk University of Technology.
Keynote: Introducing culture-based micro-interventions.

Johannes Kisser (alchemia nova, Vienna)
Works in many circular economy projects, is evaluator for social innovation competitions and has held lectureships on sustainable product design, supply chain management, CSR, circular construction, and circular cities at four Austrian universities, together with delivering countless speeches and talks at conferences on different topics around solution-oriented circular economy applications.
Keynote: The Fabrics of a Circular City.

Roman Grünner (Deep Demonstration Vienna-Climate KIC)
Specialized in sustainable buildings and renovation, renewable resources and energy efficiency, Roman was responsible for international cooperation with Slovakia and the Czech Republic and was district leader of the Bratislava delegation to the EU - GUGLE project.
Keynote: Presentation of Deep Demonstration Vienna.

Michael Fürst, Paul Schulz (Team Vivi House, IBA Vienna)
Since autumn 2017, the Vivi House construction method has been developed and tested by a team of architects, structural engineers, building physicists, construction technicians, mechanical engineers, straw bale experts and students. We want to address people who are interested in topics such as their living environment, architecture and technology, collective planning and construction processes, ecology, raw material cycles and energy efficiency.
Keynote: Presentation of Vivi House.

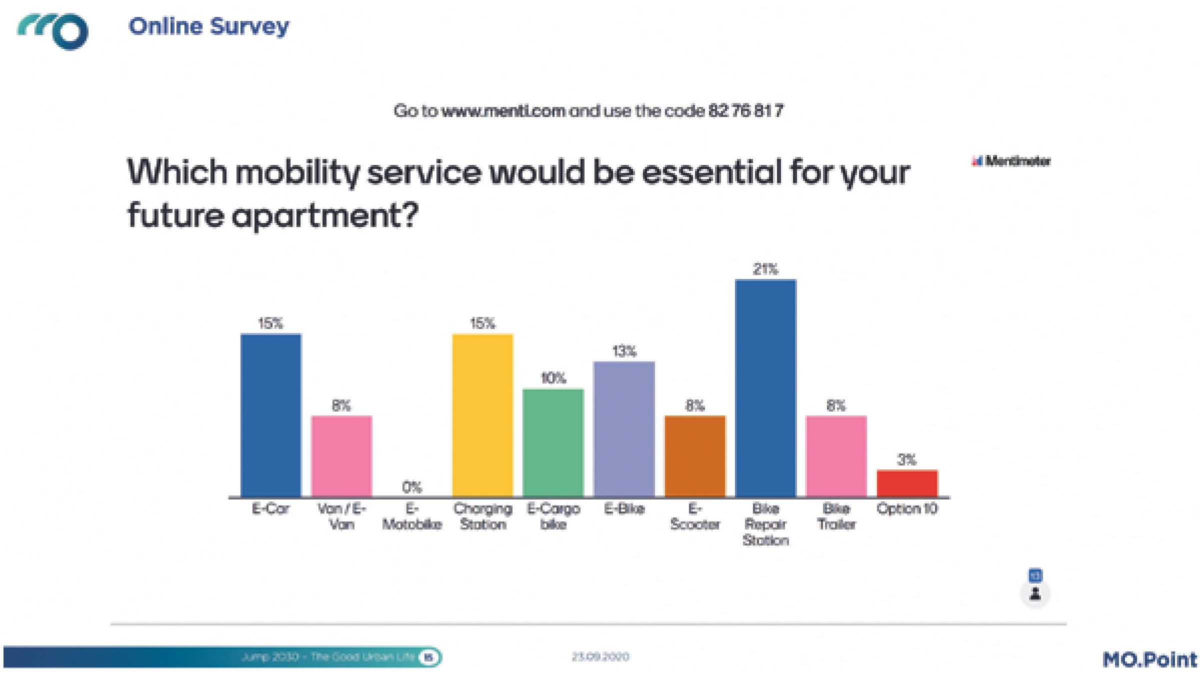


Figure 3.2. *Minipoli during the online lecture on the mobility wishes of the audience.* (Credit: Stefan Melzer)

Stefan Melzer (MO. Point, Vienna)

Co-founder and managing partner of MO.Point, responsible for finance, site planning, operations and legal issues. Extra-occupational studies on Environmental and Sustainability Management, Master's thesis on "The Implementation of Mobility Points in Residential Buildings and their impact on mobility behaviour". Keynote: Integration of sustainable mobility in urban planning concepts.

David Tudiwer (Executive Office for Building Affairs and Technology, City of Vienna)

David Tudiwer has been working at the University of Technology and is now involved in many research projects on greening on buildings.
Keynote: Regreening the Built.

Haris Piplas (Dr. ETH Zürich, Drees & Sommer Schweiz)

Experienced Expert in Urban Design and Development with a demonstrated history of projects in the architecture & planning industry, policy and academia. Skilled in Analytic Research and Urban Strategic Design Conception & Management. Keynote: Resilient Cities?

Julia Girardi-Hoog (smarter together, City of Vienna)

Social Scientist and manager with an affinity for complex issues that need to be solved and implemented in a team. Leadership experience in Human Rights and smart city contexts, (NGO and City of Vienna) with many innovative ideas now developed and implemented, trusting in science, interdisciplinary innovation, mutual respect and occasional after work drinks while playing boule.
Keynote: A Smart City leaves no one behind.

4 Site Visits

Nordbahnhof (North Railway Station)

An urban development area for 20,000 people has emerged at Vienna's North Station, which is leading the way with modern examples of affordable housing. This is an approximately 85-hectare freight yard area of the former North Railway Station, which is no longer required by the ÖBB (Austrian Federal Railways) for rail operations, and on which a new district has gradually been under development since the 1990s.

Figure 3.3. *Aerial view of the Nordbahnhof, Courtesy City of Vienna*
Figure 3.4. *Site photo (Credit: Carlo Battisti).*

Nordwestbahnhof (Vienna Northwest Railway Station)

A former railway freight station that will be transformed into a city development area in the Brigittenau district of Vienna over the following decade.

Figure 3.5. *Aerial view of the Nordwestbahnhof, City of Vienna.*
Figure 3.6. *Site photo (Credit: Carlo Battisti).*

Seestadt Aspern

A new urban centre, one of Europe's largest urban development projects taking shape in the fast-growing 22nd district in the north-east of the city. A multi-phase development through to 2028 will see the creation of high-quality housing for over 20,000 people and, eventually, an equal number of workplaces. Built on a foundation of innovative concepts and forward-looking ideas, this city-within-a-city combines high quality of life with economic drive and offers something for everyone.

Figure 3.7. *Aerial view of the Seestadt Aspern. City of Vienna, MA 18.*
Figure 3.8. *Site photo. (Credit: Carlo Battisti).*

IBA Vienna exhibition

IBA_Vienna 2022 is the first International Building Exhibition to be held in Vienna. Vienna has therefore set itself the task of developing ground-breaking proposals for new solutions and approaches to the challenges of our time. What takes centre stage is the topic of "new social housing". Everyday patterns of behavior and processes are to be questioned with regard to their relevance and accuracy and, if necessary, renegotiated; new actors are becoming involved, interlinking municipal, housing and social policy instruments and strategies in new ways. As a consequence of the thematic orientation of IBA_Vienna, the development of social neighbourhoods as products of social interaction come to the fore and are becoming a central content of the Building Exhibition.

Figure 3.9. *Entrance to the IBA Exhibition. (Credit: Carlo Battisti).*

5 Research & Projects Developed by Teams

The Vienna TS aimed to provide its trainees with valuable insights and expert views, so that they might gain an overall image of the site at Brigitta Square. Brief, site visits and lectures occupied significant amounts of time, and the working-mode resembled a hackathon, which explains why the projects were implemented at a strategic level.

The final presentation at Brunnenpassage/Yppenplatz summed up the strategic views that had been investigated, aiming at a process-oriented matrix for dealing with socio-cultural implications, circularity aspects and sustainable goals.

Figure 3.10 and Figure 3.11. *Final presentation at Brunnenpassage/Yppenplatz. (Credit: Carlo Battisti).*

The following pages show a condensed recap of the team work that underlines the strategic level of their activities.

Organisation and Support

COST Restore
EURAC Research
Stadt Wien
Gebietsbetreuung Stadterneuerung,
AIT (Austrian Institute of Technology)
International Living Future Institute

Images

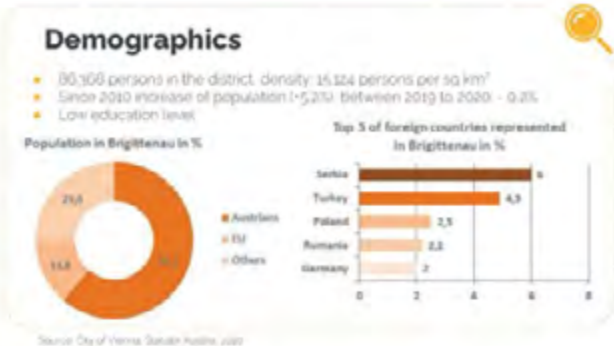
Credits: City of Vienna, Carlo Battisti, Jelena Brajkovic, Map data: Google, ©2020, MO Point, Studio Calas, Rosa Valentina Martino

Bri-Philia

Regenerative ◦ circular ◦ community for Brigittenau

Luca Caruso, Barbara Mayr, Rosa Valentina Martino, Tania Rus

Analysis of the existing places of interests along Hannovermarkt and Brigittaplatz.



District's demographics data.

SWOT analysis

Our vision, 3 pillars

Create a good urban regenerative lifestyle and test worldwide best-practices

↓

Rethink and redesign the public space of Brigittenau in a circular way

↓

Educate and collaborate with the local intercultural community to enhance acceptance

The Brigittenau to Bri-philia Circular District: the three pillar strategy

The vision

Create a good urban regenerative lifestyle creating awarness to avoid gentrification processes, rethinking and redesigning the public space in a circular way.

The Hannovermarkt, together with the ground floor of the adjacent buildings, become a social space for the inhabitants to come together, to create community spirit and to start taking care of the place and the district.

The area will be a living laboratory to understand social and sustainable issues such as climate change, recycling and reuse, as a first step, so as to raise awareness and to engage the local inhabitants in the regeneration of these public spaces.

Masterplan, strategy

Our vision for a regenerative and circular district towards a good urban life starts with pedestrianizing Gerhardusgasse and Hannovergasse streets and the layout of new bike lanes, in order to decrease the use of cars.

Strategic approach

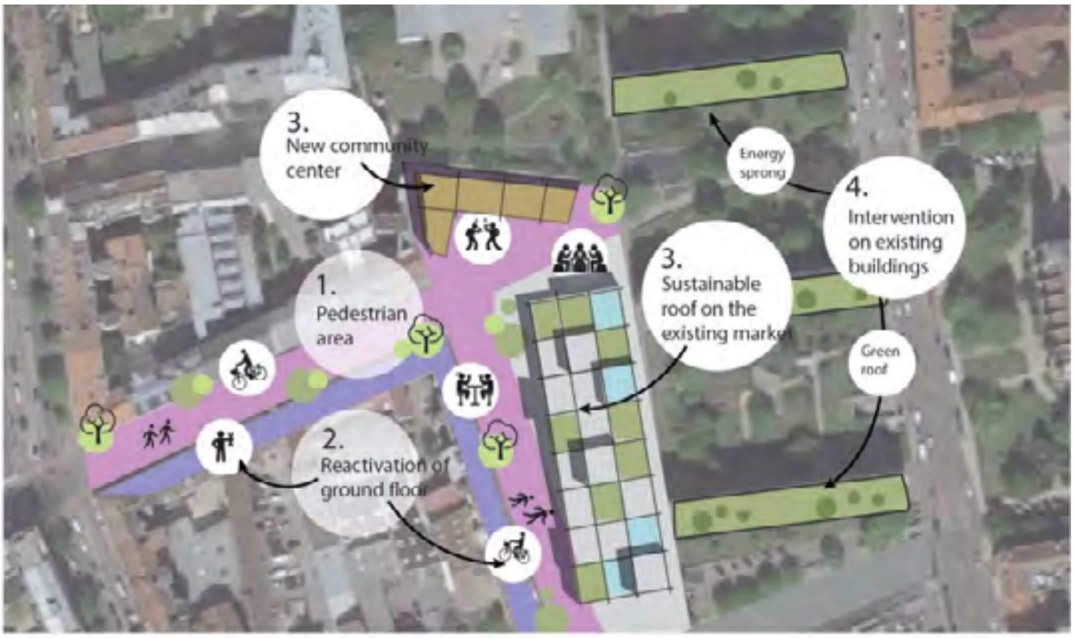
Raising awareness and education	Community as living laboratory	Implementation and scale jump	Regenerative district
Social approach	Understand and experience climate change; Explain a circular lifestyle; Promote green jobs	Building level	New Baukultur; Transform the building culture; Refurbish existing buildings; Low embodied carbon.


New community center

Strategy through timed interventions: Timeline of actions, projects and deliverables

Now	0.5-1 years	1-2 years	3-5 years
Create a pedestrian area	**Placemaking, Market & landmarks**	**Scale Jumping**	**Regenerative district**
Events & Get to know and engage the community	Community building and collaboration, small interventions, outdoor furniture	Rebuilding the market and public green spaces Green roofs and rain gardens	Building refurbishment Smart grid

...step by step



Masterplan: evolution overtime with a step by step district regeneration

Actions

Impacts on the district: Results

A **Socio - cultural**

1. Raising awareness and educating on environmental issues
2. Creating a Paradigm shift toward social justice - community integration and connections

B **Circular**

1. Reduce consumption, reuse and upcycle materials, improving recycling
2. Participatory actions - involvement of inhabitants with community modernisation
3. Circularity of natural elements - creating connections with nature - planting trees, green roofs and green façades

C **Performance**

1. Harvesting water - net positive water
2. Harvesting energy from renewable resources (PV panels on roofs) - net positive energy

Improvements on district's connection to nature

Action	Results	Co-benefits
	One **planted tree** can absorb up to 1 ton of CO2 in 40 years. Air quality improvement and acoustic pollution reduction. Reduction on heating and air conditioning demand.	1 [illegible]
	**Green roof**: energy saving in cooling and heating loads; improvement in well-being and outdoor thermal comfort. Rainwater retention → less drain for the city's sewerage network	up to 17°C Reduction in summer
	**Green facade**: Energy saving through a better insulation. Extending the life of facades (by protecting them from UV radiation, temperature differences, hail, etc.). Creation of natural habitat for humans and animals.	up to 20% U value increase

More results and co-benefits

Attributes	Proposed actions and/or projects
Water balance	Rainwater harvesting and its usage in urban farming and green rooftops
Connection with natural systems	Sensorial paths from grass, wood and stones that optimize physical and psychological health and well-being
Equity & involvement	Engaging the multi-cultural community into area development
Thermal & airflow variability	Significant reduction in thermal load, increase of wellbeing and outdoor thermal comfort
Learning and education	Rise awareness about environmental issues, reduce consumption, reuse materials and recycle

Simple but yet effective actions and related co-benefits aiming at complying the Living Community Challenge imperatives

Financing and incentives

Private

- implementation of tax rebates/deduction from income
- Extra buildable cubature in existing building renovation
- Energy service company (ESCo)

Public initiatives

- Social Impact Bonds
- Green public procurement tenders
- ESG bonds
- Affordable parking underground for residents

INTErGeneRATIONal

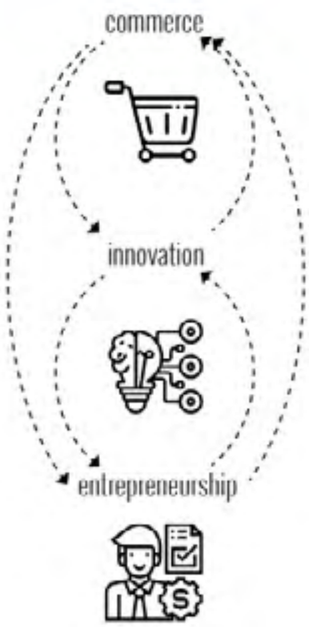
CONTEXT 2020

The aim is to consider the plot within a larger context and the future plans of the city. The terrain is located between two riverbanks and there is a new masterplan for the area in its vicinity, which acts as a seam and promotes horizontal connections. A horizontal axis linking all those important parts could be created, organizing the Brigittaplatz around two main directions. One would be the above-mentioned vibrant public axis, concentrating vivid urban life and functions and services for public use. The vertical axis will enhance the green line created with various plants and atmospheres.

public facilities
greenery
underused/challanges
solar potential
wind potential
Donaukanal

DRIVERS

social	economical	environmental



vegetation

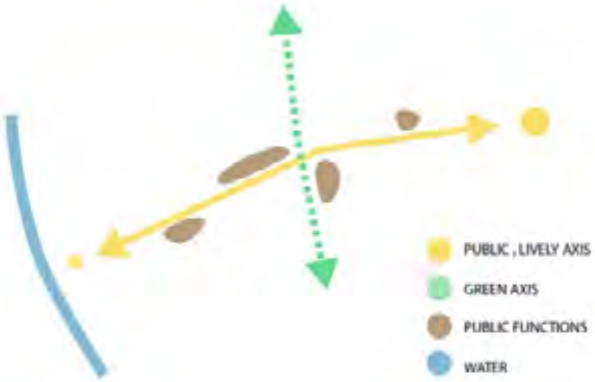
moisture content

surface temperature

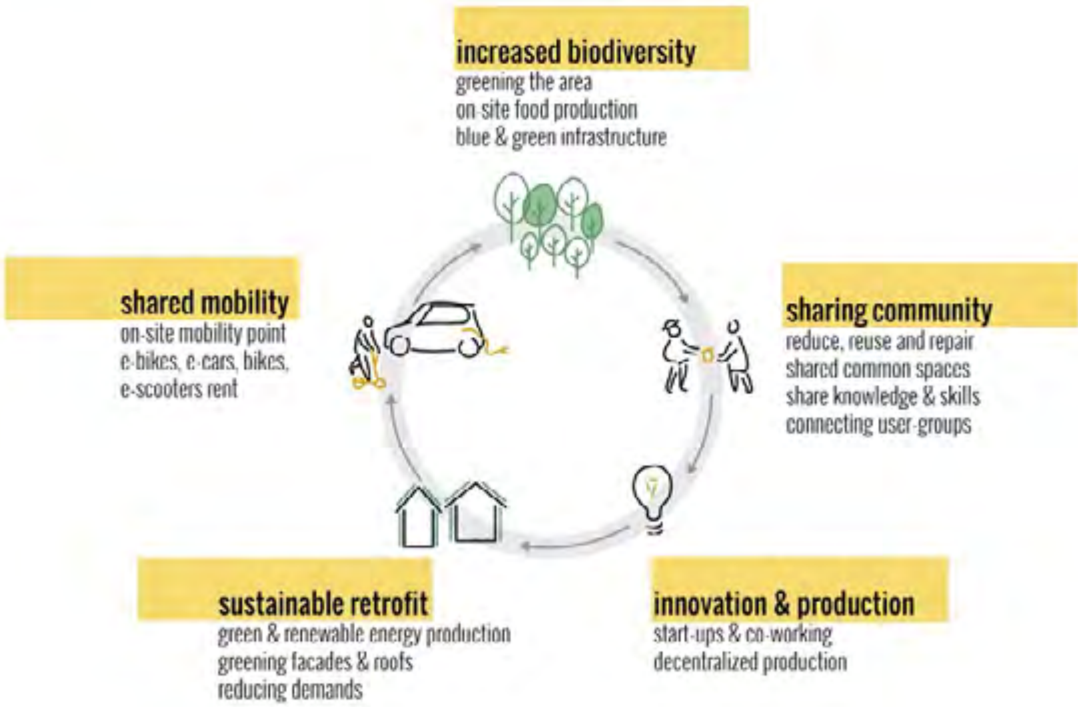
built area

Ioana Pîrv
Władka Krawska
Inka Flaszyńska
Sagnik Bhattacharya

VISION 2030



It can be seen that many social and public services have already been created along the horizontal axis (in orange). The idea is to reinforce this axis by pedestrianization of the street and parking-lot, converting it into a square, with other additional adjacent functions. These functions include an inter-generational centre (and kindergarten), to link up different age groups and cultures. Furthermore, an outdoor mall is planned, as an informal market space when needed. An important part of the project is to resolve the problem of urban overheating and underused spaces within the district, e.g., by greening the inner courtyards of the housing blocks.



step 1.
zoning
green axis
pedestrian axis
traffic reduction
tempo-limitation

step 2.
reduction of heat island
greening of roofs & facades
urban food production
glasshouses

step 3.
activation of ground level
community use
start-ups & co-working
local production
market extension

step 4.
re-assemble the market
creating friendly spaces & inviting atmosphere
more green space within the market area

step 5.
refurbishment of houses
introducing green energy
decreasing demands
creating shared community spaces

VISION 2030

green infrastructure
the garden at fingertips
courtyard 'bowl'
green balconies
greenhouses
hanging gardens
green fingers

blue infrastructure
water playground
mitigation
petrichor
mist
scent of the rain
collection of rain water

social infrastructure
reduction of consumerism
sharing skills & favours
community spaces for:
sharing books - bibliotique
sharing food - cuisinatique
sharing tools - instrumentique

recreational infrastructure
ephemerality
air, wind
life cycle
scents & wind bells
bees, butterflies, birds
wild plants, biodiversity

URBAN AMBIENCE

RE-WORKING NEIGHBOURHOOD

Tudor Luga; Qingchang He; Marián Ontkóc; Alejandra Vidales

BACKGROUND

17th century
Urban historical importance elements in the form of crossroads with buildings

19th century
A business location and settlement of machine factories

20th century
Linear development. Urban modernism originated in the 1960s

21th century
Works, elders and migrants neighbourhood

Strength:
Big greenspace in site, meeting point (lots of people going there)

Weakness:
Low quality of greenspace, fence separates space, too much parking space, lack of furniture, mix community (different cultural background), landscope design is monotonous

Opportunity:
Hold potential to form green structure, building can be refurbished, parking space can be reduced

Threaten:
Majority of the population are elderly, busy road separates the site

MAIN CONCEPT

works as a whole: safe, healthy and happiness

landmark

urban farm

WORKING NEIGHBOURHOOD

attract young people and visitors

working opportunities

bring potential
economic opportunities

SHORT TERM AND SMALL INTERVENTIONS

| Working mobility

- Remove market parking area
- No cars inside the quadral: pedestrian & bike only cross alleys
- Rearrange secondary access alley (green connection with metro): lower traffic for the in-between current garden alley
- Dynamic pricing for the underground parking
- Sharing mobility facilities: car, bike, scooter
- Recharging stations for cars & scooters

| Working landscape

- Suds: topography made water ponds
- Dog park instead of Southern parking
- Plants filtering system (vertECO | alchemia-nova) for gray water on-site treatment

| Working (circular) economy

Produce

- Vertical farming as privacy barriers (pallets from market)
- Apartment building
- Rooftop farming / PV
- New Wood-built makerspace
- Wi-fi in the public areas +f ast fiberlink for the residents

Re-use

- Recycling bins & compost re-use
- Eco toilets

| Working social design

- Outdoor public gym equipment: for elderly & outdoor public gym equipment for youngsters
- Relaxing spaces & urban furniture
  Recharging benches with PVs
- External shading blinds with human faces outwards (improved thermal comfort & district security

LONG TERM INTERVENTION, "NEW LAYER"

Productive market roof-top

Management of biowaste

Create jobs

Reduce driving distances

Provide heat and energy

Local products

Increasing food stability

Improve air quality

Reduce heat island

Retrofit apartment buildings

Multiple apartment sizes

Improved energy performance

productive part of the roof top

social part of the roof top

social part of the roof

productive part of the roof top

DATA AND CALCULATION

Total surface:	6,620 m²
Usable surface:	4,200 m²
Productive area:	approx. 3,500 m²
Soil volume:	1,400 m³
Water needed:	3,832 m³/year
Water provided:	3,699 m³/year
Jobs created:	7

Waste coverage:	280,000 kg/year
People provided:	1,600/year
Energy production from compost:	1,590 GJ/year
CO2 saving:	1,120 kg/year
Vegetable production:	22,750 kg/year
People provided (vegetables):	151 (0,4kg/day)

PV installed:	1,200 m²
Energy production:	140 MWh/year
Energy consumption:	48,6 MWh/year
Volume of wood construction:	741,25 m³
CO_2 balance:	-54,437 t

4 blocks of flats

Current energy demand:	87,8 kWh/(m².a) - each
Energy demand after retrofit:	11,5 kWh/(m².a) - each
Roof surface suited for PV:	427,43 m² - each
Energy production:	85,49 MWh/year - each

Brigitta Gardens

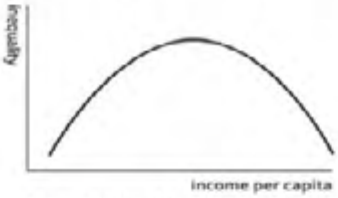
A new centre of attraction for the city of Vienna

TS5 GROUP 4
Doriana Matraku - Silvia Vian - Clemens Horvath

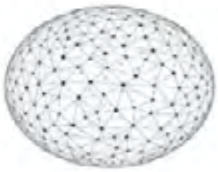
HOW TO TACKLE INEQUITIES

20th century

It's got to get worse before it gets better - and growth will make it better.



21st century



Don't wait for growth to even things up because it won't. Be distributive by design.

Economic Model from the distribution of income to the distribution of resources

SWOT Analysis (S+W)





Strenghs and Weaknesses

- BP it is near Danube Channel
- BP it is close to Brigitta Church
- BP has a well-known market Hannovermarkt
- High level of density of population (more then 500)
- Close of new development area (NordwestBahnhof)
- Young population (up to 26 years old)

multiethnic structure/diversity of inhabitants

- 0-13% of population has Higher Education
- more than 17% is the unemployment rate in this area (in Vienna city U=11.7%)

www.wienstad.gv.at




Masterplan Scale

Proposed
- Area of Intervention
- Green/Blue Link
- Sub Connection (cycle)
- Future Link

Existing / Construction In Progress
- Green Link
- Blue Link - Donau Canal
- Urban Centres of Aggregation
- Green Centres of Aggregation

Local Scale

Food Hall & Playground Hall
- **economical function** addition to the area
- a new **enclosed space for gatherings**
- **compensation** for old areas of the market that are no longer needed
- designed as a light timber structure, it will also serve as an **attraction point** leading to the development.

Water Feature Square
- improvement of the **microclimate**
- **playful use** by childern and not only
- the water feature also refers to the history of the area as **wetlands** before the regulation of the Danube

Playstreet to Danau Channel
- **traffic-calmed street**
- **urban furniture** that follows the design and materiality of the food hall used as **market stands**
- **boulevard** to stroll along
- access to **public internal courtyard** with functions of i.e. **L&D points**

Hannover Market
- **diversity and culture as indentity forming factors** united below a common roof under whose protection, exchange and living can happen a necessity
- The **market canopy, a light timber structure, will visually unite** the market to the rest of the new development

Flower&Vegetable Garden
- conversion of existing parking to **productive and recreational space for locals, community participation**
- key element for **circular economy.** Organic waste produced by the market can be reused as compost and subsequently provides fuits, vegetables and flowers for the market and the food hall.

F&V Garden Benefits
- **Waste management**
- Improve **mental health and community involvement**

Neighborhood Library
- **Literary evenings**
- **World literature** aiming of community involvement
- **Forums and online reading** practice
- **Subscription** cards
- **Most saled books** stand
- **Local and foreign daily press** stand

Learning&Development
- **alternative education** organization involvement
- **psychosocial and health support**
- **didactic materials provision**
- Identifying **businesses to hire** employees **and transfer know-how**

Build&Adventure
- **physical, mental and spiritual development** (hiking, backpacking)
- **survival skills** (camping, woodcraft, aquatics)
- **awareness campaigns** on threats, risks and help ing eachother
- planning, implementation, monitoring and evaluation processes

Library, L&D and B&A Benefits
- **physical and psychological performance**
- **community learning**
- embody **principles of equality and inclusiveness**
- promote **cultural diversity**
- **youth involvement** in culture

THE ARCHITECTURAL VISION

Area of Intervention

Lightweight timber structures with acoustic properties to let the children play in a natural and safe environment ensuring visual connections and natural light

Food hall and Market Hall as a new centre to discover and to connect with the cultural richness of Brigitta Platz.

The Brigitta Church Roof pattern gives design unity the development and is also the leitmotif pattern of the street paving and wayfinding.

SWOT Analysis (O+T)

Opportunities

- Organizing activities, festivals, competitions
- Raising employment rates
- Improving quality of life
- Interaction between children from different communities

Threaths

- Gentrification
- Taking in balance the development of the area
- Good management from Municipality

REGENERATIVE CO-BENEFITS

1. increase biodiversity	• new planting (flower&vegetable garden+ Boulevard)
2. clean and controlled water	• rainwater collection stream + irrigation with rainwater from BP Roof
3. manage localized microclimatic conditions	• low level articial pond
4. energy positive	• PVs on roof/wall of Brigitta Platz buildings and Hannover Market
5. looping material flows	• vegetable garden to produce for food hall and waste to reuse in it
6. maximize and activate existing space and buildings	• reducing market buildings to have square
7. mobility and pedestrian design	• Brigitta Church playstreet emplementation till Donau Kanal
8. restorative built, green and blue spaces	• street asphalt to be replaced by permeable aggregates compound
9. urban agriculture	• flower/vegetable garden by locals
10. increase air quality	• new planting and pond
11. achieve biophilia	• biophilic lightweight timber structures with acoustic properties
12. social integration	• food hall and market will use local knowhow for production
13. increase site accessibility	• augmented playstreet, new connection with existing pedestrian canal walk

4. Glossary

A New Lexicon for Regenerative Built Environments

Shifting our language from one that is combative, competitive and mechanistic to one that is collaborative, inclusive and naturalistic is essential for a regenerative future. (WG1) Examples used throughout RESTORE include the language shift *from* Fixing > *to* Caring, *from* Linear > *to* Circular, *from* Occupant > *to* Inhabitant, *from* Innovation > *to* Emergence., *from* Producing > Cultivating, *from* What If > What Is, *from* Consumption > *to* Prosumption and *from* Construction > Prostruction (COST RESTORE Working Group (WG) Papers and Workshops, www.eurestore.eu).

Biodiversity

“The variability among living organisms from all sources including, inter alia, terrestrial, marine and other aquatic ecosystems and the ecological complexes of which they are part; this includes diversity within species, between species and of ecosystems.” (International Union for Conservation of Nature, IUCN Definitions. Retrieved from https://www.iucn.org/sites/dev/files/iucn-glossary-of-definitions_en.pdf).

Biomimicry

“Biomimicry (from bios, meaning life, and mimesis, meaning to imitate) is a new science that studies nature’s best ideas and then imitates these designs and processes to solve human problems. … I think of it as ‘innovation inspired by nature.” (Benyus, J. (2014). Biomimicry Explained: A Conversation with Janine Benyus. Retrieved from https://biomimicry.net/the-buzz/news/biomimicry-explained-conversation-janine-benyus/).

Biophilia

The Love of Life, our innate relationship with nature - “innately emotional affiliation of human beings to other living organisms. Innate means hereditary and hence part of ultimate human nature.” (Wilson, E. O. (1984). Biophilia: The Human Bond with Other Species (p.31). Cambridge, MA: Harvard University Press).

Biophilic Design

Connecting to experiences of nature and life through design (Bochart, S., Brown, M., Sturgeon, A. (2020). USGBC).

“Biophilic design is the designing for people as a biological organism, respecting the mind-body systems as indicators of health and well-being in the context of what is locally appropriate and responsive. Good biophilic design draws from influential perspectives – health conditions, socio-cultural norms and expectations, past experiences, frequency and duration of the user experience, the many speeds at which it may be encountered, and user perception and processing of the experience – to create spaces that are inspirational, restorative, and healthy, as well as integrative with the functionality of the place and the (urban) ecosystem to which it is applied. Above all, biophilic design must nurture a love of place.” (Terrapin Bright Green (2014). 14 Patterns of Biophilic Design. Retrieved from https://www.terrapinbrightgreen.com/reports/14-patterns/#biophilia-in-context).

Building Information Modelling

A process involving the generation and management of digital representations of physical and functional characteristics of places. Building Information Models (BIMs) are computer files which can be extracted, exchanged and networked and that describe the characteristics (including metadata) of the concerned built asset (*e.g.* a building).

Built Environment

The human created environment that provides the setting for human activity, ranging in scale from constructed spaces to buildings, cities and beyond.

Carbon Neutrality

The term refers to a state of balance between the CO2 emitted into the atmosphere and the CO2 removed from the atmosphere. Concept of a state in which human activities result in no net effect on the climate system Synonymous with Carbon Positive and Net Zero Carbon (Intergovernmental Panel on Climate Change (IPCC) (2018). Annex I: Glossary [Matthews, J.B.R. (Ed.)]. In: *Global Warming of 1.5°C. An IPCC Special Report on the impacts of global warming of 1.5°C above pre-industrial levels and related global greenhouse gas emission pathways, in the context of strengthening the global response to the threat of climate change, sustainable development, and efforts to eradicate poverty* [Masson-Delmotte, V., P. Zhai, H.-O. Pörtner, D. Roberts, J. Skea, P.R. Shukla, A. Pirani, W. Moufouma-Okia, C. Péan, R. Pidcock, S. Connors, J.B.R. Matthews, Y. Chen, X. Zhou, M.I. Gomis, E. Lonnoy, T. Maycock, M. Tignor, and T. Waterfield (Eds.)]. In Press. (pp. 544, 545, 555). Retrieved from https://www.ipcc.ch/sr15/chapter/glossary/.

Circular Economy

A systemic approach to economic development designed to benefit businesses, society, and the environment. Circular Economy Principles: Eliminate waste, pollution, negative social and environmental impact; Keep products and materials in use; Regenerate Natural Systems (Ellen MacArthur Foundation (n.d.). What is Circular Economy? Retrieved from https://www.ellenmacarthurfoundation.org/circular-economy/what-is-the-circular-economy).

Climate Emergency

Term used to describe the state of human-caused climate change, an alternative term for global warming, climate crisis or climate breakdown. As defined by the Oxford Dictionary, a climate emergency is a “situation in which urgent action is required to reduce or halt climate change and avoid potentially irreversible environmental damage resulting from it.” (Oxford Languages (2019). Word of the Year 2019. Retrieved from https://languages.oup.com/word-of-the-year/2019/#:~:text=The%20Oxford%20Word%20of%20the%20Year%202019%20is%20climate%20emergency). A Climate emergency declaration, is a public declaration and recognition of a state of climate emergency. Currently linked with Ecological Emergency to illustrate the relationship between climate and ecological breakdown.

Component (Parametric Design)

Functional blocks used in parametric design. Each component contains data or performs actions. The establishment of the relationships in the parametric model is performed through dynamic linking of the components.

Computational Fluid Dynamics (CFD)

CFD is computer numerical analysis used to analyze the flows of fluids, liquids and gases, in relation to surfaces. In architecture, urban design and planning CFD is used to simulate the behavior of wind flows though urban areas with buildings, at different scales, for the evaluation of mechanical and thermal effects, the dispersion of pollutants, and the propagation of fire.

Daylight

The natural light available from the solar energy present in indoor and outdoor building environments, available from direct sunlight, diffused by the sky and reflected by the environment, which has positive effects on human physiological and psychological well-being, indoor and outdoor comfort, and resource efficiency.

Degenerative Economy

Economic growth and development linked to increasing consumption of finite resources (Fairsnape, Brown, M. (2020). Regenerative Sustainability in Nine Graphics. Retrieved from https://fairsnape.com/2020/09/01/regenerative-sustainability-in-eight-graphics/.

Digital Twin

There are multiple definitions of a Digital Twin. One is the following: A digital twin is a real-time digital replica of a living or non-living physical entity.

Distributed Ledger Technology (DLT)

Digital systems for recording the transaction of assets and/or resources, in which the transactions and their details are recorded in multiple places at the same time. Unlike traditional databases, distributed ledgers have no central data store or administration functionality. In a distributed ledger, each node processes and verifies every item, thereby generating a record of each item and creating a consensus on each item's veracity.

Doughnut Economy

A visual representation of the safe place for growth between the ecological ceiling and the social foundation – a visual framework for sustainable development (Raworth, K. (2017). Doughnut Economics: Seven Ways to Think Like a 21st-Century Economist, Cornerstone Digital).

Ecoliteracy

Ecoliteracy is defined as the ability to understand the natural systems that make life on earth possible. An ecoliterate person will understand the principles of organization of ecological communities *(i.e.* ecosystems) and use those principles for creating sustainable human communities. The term was coined by American educator David W. Orr and physicist Fritjof Capra in the 1990s thereby a new value entered education; the "well-being of the earth". An ecologically literate society would be a sustainable society that did not destroy the natural environment on which it depended (COST RESTORE-WG1, Brown, Haselsteiner at al. (2017). Sustainability, Restorative to Regenerative (p. 36) Eurac Research. Retrieved from https://www.eurestore.eu/wp-content/uploads/2018/05/RESTORE_booklet_print_END.pdf).

Embodied energy (EE)

Total (direct and indirect) energy required to produce economic or environmental goods and services. Unlike the direct energy measurement of energy consumption, it refers to the energy consumed by all other products and services used in the manufacturing, maintenance, and processing of products. See Upfront Carbon.

Emerging materials

Innovative and cutting-edge materials in the construction industry, including materials changing their properties depending on the environment (phase-change materials) and restorative materials such as: self-healing materials; materials improving the indoor/outdoor air quality; etc.

Emergy

The total available energy (exergy) of one kind that was required (used up) directly or indirectly in the work of making a product or a service.

Energy Island

(Geographical and Non-geographical): Integrated local energy systems (Energy Islands) The fast growth of energy production from renewable energy sources offers new and economically attractive opportunities for decarbonizing local energy systems (*e.g.* isolated villages, small cities, urban districts, rural areas with weak or non-existing grid connections).

Human – Nature – Built Environment Nexus

Using the principles of nature to create a symbiotic regenerative built environment with regenerative human and planetary health (Brown, M. (2020). COST RESTORE – WG5. www.eurestore.eu).

Information and Communications Technology (ICT)

An extension of Information Technology (IT) that refers to infrastructure and components of networking, applications and systems that when combined, give people and organizations the tools to interact in the digital world (ICT, 2020).

Internet of Things (IoT)

A network of physical objects, or "things" that are embedded with sensors, software, and other technologies for the purpose of connecting and exchanging data with other devices and systems over the Internet.

Living Futures

A future built environment that is socially just, culturally rich and ecologically sound (International Living Future Institute (n.d). Socially Just, Culturally Rich, Ecologically Restorative. Retrieved from https://living-future.org/our-impact/)

Machine Learning

Set of computational procedures used to obtain predictions in architecture and urban design related to the usage patterns of inhabitants, effects of climatic factors, energy and life cycle among others, through the training of the system.

Nature-Based Solutions (NBS)

European Commission defines NBS as solutions that are "inspired and supported by nature, which are cost-effective, simultaneously provide environmental, social and economic benefits and help build resilience. Such solutions bring more, and more diverse, nature and natural features and processes into cities, landscapes and seascapes, through locally adapted, resource-efficient and systemic interventions." (Connecting Nature (n.d). Nature-Based Solutions Explained. Retrieved from https://connectingnature.eu/nature-based-solutions-explained).

nearly Zero Energy Buildings (nZEB)

According to the EPBD, a nearly zero energy building is a "building that has a very high energy performance (...). The nearly zero or very low amount of energy required should to a very significant extent be covered by energy from renewable sources, including renewable energy produced on-site or nearby." (European Commission (n.d). nZEB. Retrieved from https://ec.europa.eu/energy/content/nzeb-24_en?redir=1).

Optimization

The process that uses variables and objectives to find the best solution (single objective) or a number (multi-objective) of solutions fulfilling them. Optimization tools are available for designers through components available in parametric design software or as dedicated scripts.

Parametric Design

Design method through computer software with which relations may be established between project conditions, factors and elements, in the form of parameters, such as site, building program, urban environment and climatic factors.

Plus Energy Buildings (PEB)

Buildings that can produce more energy than they consume and contribute to the energy support of other buildings connected to them, creating a system of units connected together at the neighbourhood level, aiming to obtain neutrality or, in extreme cases, energy positivity.

Positive Energy District (PED)

A PED is a district composed of several buildings connected to each other to contribute to the energy supply of the whole neighbourhood through a "smart" distribution of energy networks. It couples built environment, sustainable production and consumption, and mobility to reduce energy use and greenhouse gas emissions and to create added value and affordable standard of living for its inhabitants.

Regenerative Buildings

Buildings that create conditions for all live to thrive (COST RESTORE-WG1, Brown, Haselsteiner *et al*. (2017). Restorative Sustainability (The Faro Papers). Accessed at https://www.eurestore.eu/working-groups/wg1-restorative-sustainability/).

Regenerative Economy

The art and science of building wealth-generating capacity into living systems at all levels and at all scales (Sanford, C., Haggard, B. (n.d.) The Regenerative Economic Shaper Perspective Paper— Part 1. Retrieved from https://medium.com/the-regenerative-economy-collaborative/the-regenerative-economic-shaper-perspective-paper-part-1-8cd56d77f4b0).

Regenerative Tourism

A more considered, responsible slower route to tourism, seen as a healing sector that revives and resuscitates the visitor economy, enabling it and the people in it to flourish forever.

Resilience

Describes the capacity and flexible ability to recover quickly from difficulties and problems.

Restorative and regenerative materials

Materials aiming to restore the built environment to a healthy state. Examples of restorative materials include self-healing materials and materials for improving indoor/outdoor air quality.

RESTORD 2030

The imaginary small European city that in 2020 applied the outcomes from EU Cost Action RESTORE, such that in 2030 it became the exemplar regenerative city (Brown, M. (2020). COST RESTORE-WG5. www.eurestore.eu).

Rewilding Cities

Integrating restorative measures to reconnect to a functioning ecosystem. Currently most cities are disconnected from nature and face major climate-crisis-related challenges (Kilduff, R. (n.d.) City Rewilding, Rewilding Earth. Accessed https://rewilding.org/city-rewilding/).

Scale Jumping

The transition from a sustainable built environment to one that is regenerative and enables life to thrive (COST RESTORE-WG1, Brown, Haselsteiner at al. (2017). Restorative Sustainability (The Faro Papers). Accessed at https://www.eurestore.eu/working-groups/wg1-restorative-sustainability/).

Seva

Regenerative paradigm, thinking and practice that sees ourselves and the built environment as part of nature, not apart from. From the Sanskrit word 'Seva' translated as service, as being in service to a larger whole, without reward, and giving more back than taken. The understanding of our position on the planet, which can be called a worldview, has a crucial role in building the awareness for regenerative sustainability. The transition to this worldview, is expressed as the transition from Ego to Eco to Seva (COST RESTORE-WG1, Brown, Haselsteiner at al. (2017). Sustainability, Restorative to Regenerative (p.11). Eurac Research. Retrieved from https://www.eurestore.eu/wp-content/uploads/2018/05/RESTORE_booklet_print_END.pdf).

Smart and regenerative city

A city aiming at answering human needs, solving societal challenges and increasingly efficient use of resources and systems leading to the circular economy. It needs to be based on the interconnectivity and the interoperability of its systems and founded on an integrated, holistic approach.

Socio-Cultural Acceptance

Compound term to describe a large group of people embedded in the social relations and the culture in which they live.

Tactical Urbanism

Mostly low impact and low budget measures in changing temporary conditions in the built environment.

Thermal Comfort

The condition of mind that expresses satisfaction with the thermal environment and is assessed by subjective evaluation (ANSI/ASHRAE (2013). Standard 55-2013: Thermal Environmental Conditions for Human Occupancy. Atlanta). Thermal comfort is determined by body heat gains and losses with the environment, the main factors for which are metabolic rate, clothing insulation, air temperature, mean radiant temperature, air speed and relative humidity.

Thrivable Buildings

The intention and practice of aligning the built environment, as eco systems, with how living systems thrive.

Traditional materials

Materials which have been used traditionally, mainly natural materials, for example stone, reinforced concrete, mortars, gypsum plaster, bricks, timber, adobe.

Upfront Carbon

The emissions caused in the materials production and construction phases of the lifecycle before the building or infrastructure begins to be used. Recognised as the most important aspect of carbon emissions that must be addressed and reduced to meet built environment carbon targets (World GBC, (2019). Bringing embodied carbon upfront. Retrieved from https://www.worldgbc.org/sites/default/files/WorldGBC_Bringing_Embodied_Carbon_Upfront.pdf).

Urban Hacks

Urban hacktivism is mostly a citizen-led problem-solving process addressing the not-so-well-perceived public urban environment. Urban hacks aim to raise awareness and lead to further actions.

Urban Heat Islands (UHI)

Urban areas experience much warmer temperature than nearby rural areas. The main cause for UHI is the sealing and modification of land surface and the higher presence of thermal mass in the urban fabric.

Wellbeing

Wellbeing for citizens is the result of individual, social and cultural variables and their interactions and is distinct from happiness because wellbeing entails an evaluation of how people think and feel about their lives as opposed to "instant" happiness (COST RESTORE-WG1, Brown, Haselsteiner at al. (2017). Sustainability, Restorative to Regenerative (p. 37). Eurac Research. Retrieved from https://www.eurestore.eu/wp-content/uploads/2018/05/RESTORE_booklet_print_END.pdf).

3D printing or Additive Manufacturing

"Additive manufacturing is the general term for those technologies that based on a geometrical representation creates physical objects by successive addition of material. These technologies are presently used for various applications in the engineering industry as well as other areas of society, such as medicine, education, architecture, cartography, toys and entertainment." (ISO/ASTM 52900-15 (2015). Additive manufacturing — General principles — Terminology. Retrieved from https://www.iso.org/standard/69669.html).

COST Action RESTORE Working Group 5 has focused its work on investigating Scale Jumping Potentials and Strategies, Regenerative Systems Thinking and Implementation within the Built Environment. This book presents the final results and concludes the work of RESTORE Working Group 5 which has further developed the research and strategies defined throughout the previous four working groups. The concepts that RESTORE established and developed are deepened in this publication, and are interconnected and placed within the context of systems thinking and scale jumping approaches, working towards the regenerative future of our built environment.

In this book, scale jumping potentials and strategies will be addressed, recognizing the imperative need for regenerative systems thinking built into a multidisciplinary approach, in order to achieve balanced and regenerative growth of our built environment. The application of systems thinking to the built environment will be addressed in the first part of the book that presents studies on **interactions** within the human-nature-built environment triangular matrix. Within this nexus, regenerative scale jumping concepts will be presented through patterns of triangular interactions, but also some more specific insights into human-built and nature-built environments.

The second part of this book will focus on the **implementation** of the scale jumping regenerative strategies for the built environment through **tools, platforms, metrics and practice**. Scale Jumping will be addressed through the following approaches: Digital Tools to Support District Regenerative Design and Scale Jumping; Smart Technologies in the Context of Regenerative Design; Emerging Technologies; Design Frameworks to Scale Up within Area Regenerative Practices and EU Policy Documents for Green Transition.

This **Guidelines for Regenerative Implementation** therefore offers analysis and solutions that should be of interest **to** both **practitioners and academics** who wish to explore scale-jumping strategies and potentials for the implementation of regenerative sustainability at neighbourhood and city scales and throughout society.

About Editors

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COST Action CA16114 RESTORE: REthinking Sustainability TOwards a Regenerative Economy, Working Group Five: Scale Jumping, printed by Eurac Research (Bolzano, IT)

ISBN 978-3-9504607-8-0 (Online version)
ISBN 978-3-9504607-9-7 (Printed version)

Cover Page Credits: Cover Design: Jelena Brajković, Cover Images: Unsplash/Annie Spratt, Adobe Stock/tish11, COST RESTORE Training School 5/Marián Ontkóc