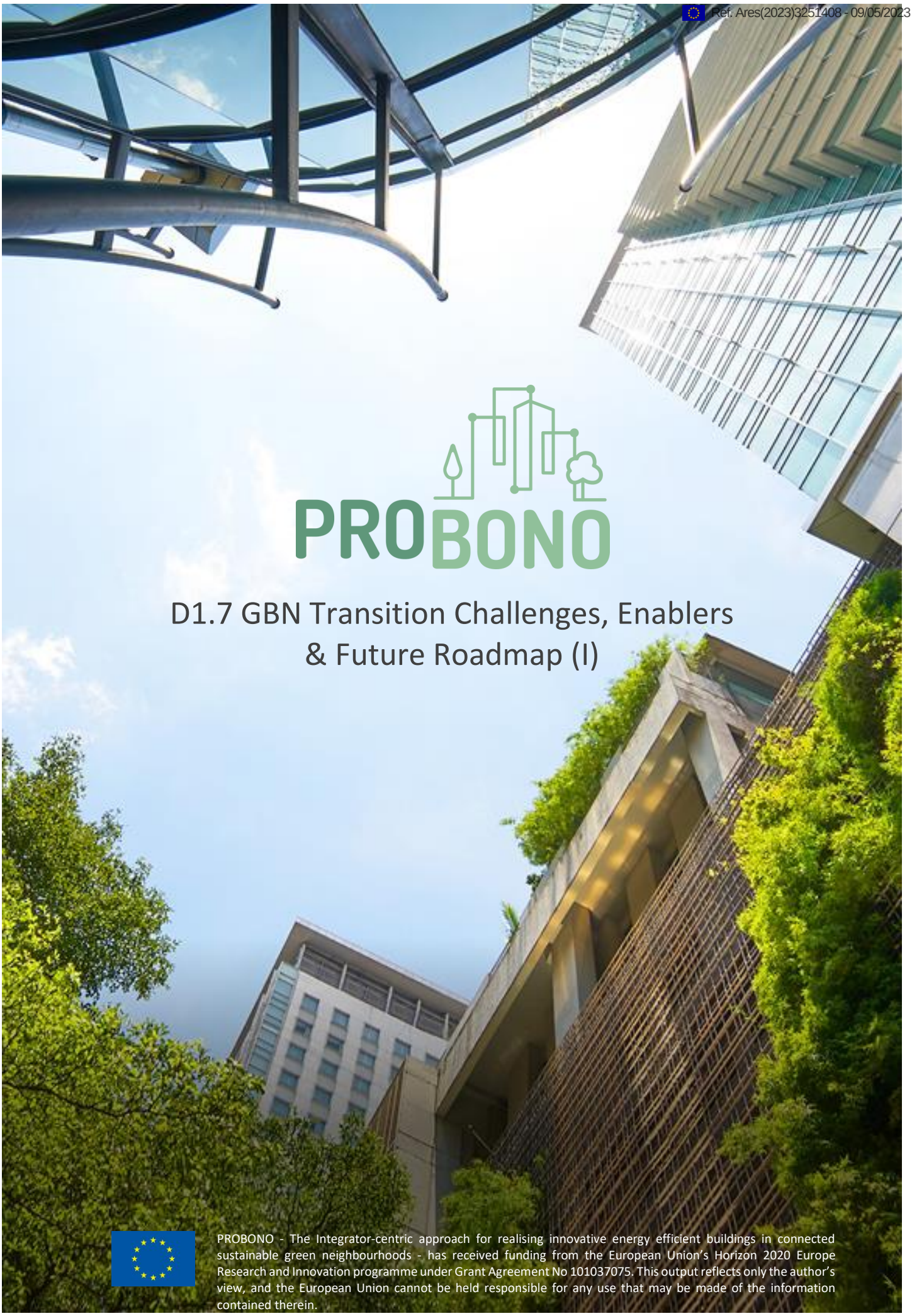

PROBONO

D1.7 GBN Transition Challenges, Enablers & Future Roadmap (I)

PROBONO - The Integrator-centric approach for realising innovative energy efficient buildings in connected sustainable green neighbourhoods - has received funding from the European Union's Horizon 2020 Europe Research and Innovation programme under Grant Agreement No 101037075. This output reflects only the author's view, and the European Union cannot be held responsible for any use that may be made of the information contained therein.

Deliverable nº:	**D1.7**
Deliverable name:	**GBN Transition Challenges, Enablers & Future Roadmap (I)**
Version:	**2.0**
Release date:	**30/04/2023**
Dissemination level:	**Confidential**
Status:	**Peer-reviewed**
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Document history:

Version	Date of issue	Content and changes	Edited by
0.	01/09/2022	First draft version	Martin Capitaine ; Sissa Bekombo Priso ; Alejandra Castellanos ; Antoine Lelong
1	05/10/2022	Second for confirmation	Martin Capitaine ; Sissa Bekombo Priso ; Alejandra Castellanos ; Antoine Lelong
2	20/03/2023	Final draft fot GBN Committee review	Martin Capitaine ; Sissa Bekombo Priso ; Alejandra Castellanos
3	28/04/2023	Submitted version	Martin Capitaine ; Sissa Bekombo Priso ; Alejandra Castellanos

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Deliverable beneficiaries:

WP / Task
WP1
WP2
WP5
WP7

DEFINITIONS[1]

A Green Building (GB) (new or retrofit) is a building that, in its design, construction and operation, reduces or eliminates negative impacts, and can create positive impacts, on the climate, social, and natural environment. GBs preserve precious natural resources and improve quality of life[2]. Specifically, this means that GBs should be very energy efficient, use extensively the potential of locally available renewable energy, use sustainable materials, and aim for a low environmental impact over the entire life cycle. GBs offer their users and residents a healthy climate and a high quality of stay, they are resilient e.g., to environmental change and contribute to social inclusion.

Green Neighbourhoods aligned with the European Green Deal[3], is a set of buildings over a delimited area, at a scale that is smaller than a district, with potential synergies, in particular in the area of energy. A green neighbourhood is a neighbourhood that allows for environmentally friendly, sustainable patterns and behaviours to flourish e.g., bioclimatic architecture, renewable energy, soft and zero-emission mobility etc. Green neighbourhoods are the building blocks of Positive Energy Districts (PEDs)[4] by implementing key elements of PED energy systems. For example, the exchange of energy between buildings increases the share of local self-supply with climate-neutral energy and system efficiency. They also provide the technical conditions to enable Citizen Energy Communities[5] and Renewable Energy Communities[6] to be implemented.

Green Buildings and Neighbourhoods (GBN) in PROBONO are GBs integrated at delimited area or district level with green energy and green mobility management and appropriate infrastructure supported by policies, investments and stakeholders' engagement and behaviours that ensures just transition that maximise the economic and social cobenefits considering a district profile (population size, socio-economic structure, and geographical and climate characteristics). Delivered in the right way, GBN infrastructure is a key enabler of inclusive growth, can improve the accessibility of housing and amenities, reduce poverty and inequality, widen access to jobs and education, make communities more resilient to climate change, and promote public health and wellbeing.

DGNB certification serves as a quality stamp ensuring the state of the building for buyers. The Green Building Council Denmark (2010) established the German certification DGNB meaning 'German Society for Sustainable Buildings'. The Danish version of DGNB was created to obtain a common definition of what sustainability is towards and making it measurable. A consortium of experts was established from all parts of the construction sector. DGNB had to be reshaped for the Danish standards, practice, traditions, and laws but is now available to certify any construction project. They chose DGNB as an innovation-forward and sustainable future guarantee. DGNB diversifies itself by focusing on sustainability and not just the environment. DGNB creates a standardised framework for the construction operations conditions and creates a common language which facilitates communication between professions and helps organize and prioritize the efforts in long and complicated development phases.

[1] Please refer to the last submitted reports for the latest status of the definitions

[2] https://www.worldgbc.org/what-green-building

[3] European_Green_Deal_EN_200710_fin

[4] SET-Plan Action 3.2: https://setis.ec.europa.eu/system/files/setplan_smartcities_implementationplan.pdf

[5] Internal Electricity Market Directive (EU) 2019/944 5 Renewable Energy Directive (EU)

[6] Renewable Energy Directive (EU) 2018/20012018/2001

Life cycle assessment (LCA)[7] is a tool used for the systematic quantitative assessment of each material used, energy flows and environmental impacts of products or processes. LCA assesses various aspects associated with development of a product and its potential impact throughout a product's life (i.e., cradle to grave) from raw material acquisition, processing, manufacturing, use and finally its disposal. In PROBONO, LCA represents the statement of a building's total energy, resource consumption and environmental impact in the manufacture, transport, and replacement of materials and for its operation over its expected life. Social life cycle assessment (S-LCA)[8] is a method to assess the social and sociological aspects of products, their actual and potential positive as well as negative impacts along the life cycle. Life-cycle costing (LCC)[9] considers all the costs incurred during the lifetime of the product, work, or service.

[7] https://op.europa.eu/en/publication-detail/-/publication/16cd2d1d-2216-11e8-ac73-01aa75ed71a1/language-en

[8] https://www.lifecycleinitiative.org/starting-life-cycle-thinking/life-cycle-approaches/social-lca/

[9] https://ec.europa.eu/environment/gpp/lcc.htm

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Abbreviations and Acronyms

Acronym	Description
CA	Consortium Agreement
DGNB	German Sustainable Building Council (in german: Deutsche Gesellschaft für Nachhaltiges Bauen)
DoA	Description of Action (annex I of the Grant Agreement)
EC	European Commission
GA	Grant Agreement
ISO	International Organization for Standardization
PC	Project Coordinator
PESTEL	Contextual analysis around 6 categories: Politic, economic, social, technologic, environment, legal.
PMC	Project Management Committee
PO	Project Officer
PS	Project Secretariat
QM	Quality Management
SC	Scientific Coordinator
TMT	Technical Management Team
TL	Task Leader
ToC	Table of Contents
WP	Work Package
WPL	Work Package Leader

Executive Summary

The aim of this report is to cover the requirements defined in the PROBONO Grant Agreement, under Subtask ST1.4.1 which can be summarized as:

"ST1.4.1: Contextual Analysis Cycle. Determine the framework for interweaving contextual elements into the GBN lifecycle, from planning to operation. Establish an iterative procedure for refinements and perform initial Living Labs analysis using a PESTLE framework"

- WHY - Methodology (CF T1.1 D1.1)

Due to their innovative nature, Green Building Neighbourhood (GBN), especially those implicated in the PROBONO study, are subjected to challenges in their design, implementation, and adoption by the users. From a technical point of view, the creation of a GBN requires an ambitious mix of eco-friendly approaches, solid construction method and the integration of new technologies. From a practical point of view, GBNs must be accepted by local citizens. This requires an adoption of the technology by the users and the GBN must perfectly adapt to the societal issues and to the lifestyle of the locals.

Therefore, it is important to define major current challenges and list other general or common ones. In this regard, the PESTLE (Political, Economic, Social, Technological, Environmental and Legal) analysis can be a potent mean to define the most important challenges regarding the GBN implementation. To carry out a PESTLE analysis, it is essential to have a good knowledge of the context in which it takes place. Thus, the aim of Task 1.4 is to provide a methodology that can be applied by local actors to carry out a PESTLE analysis during the implementation of a GBN. This methodology is based on an identification of the challenges faced by the members of the consortium. The inputs are then applied to enrich the implementation of standards for management system for sustainable development in communities, such as the ISO 37101, or obtain building's certifications like the DGNB.

Then, an example of a qualitative PESTLE analysis was carried out on the LL of Brussels to illustrate the elements of context and the solutions which one can obtain within the framework of the realization of this analysis. To finalise, a comparison with other PESTLE analysis regarding the implementation of resilience and rehabilitation projects in Europe, allows to identify additional elements that facilitate the spatial scale transition between the LL building and the district or neighbourhood.

In the next deliverables (D1.8, D1.9), this methodology will be developed to bring quantitative elements that can be integrated in a TD and the links between the PESTLE analysis and the ISO37101 and DGNB certifications will be illustrated with concrete examples from the Brussels PESTLE analysis.

- WHAT - General implementation

This task is structured to best assist decision makers to understand how the elements of the framework can impact the different stages of the neighbourhood life cycle, from planning to end-of-life. It is accompanied by a transition roadmap showing the key steps to be taken to achieve the EU's "Green 2050" vision.

Thus, the main elements of the framework are first defined, then for each element, the type of information needed and the actors possessing this information.

The goal is to succeed in collecting this information and to define a roadmap on the life cycle of GBN through the case studies of Living Labs (LLs).

- HOW – Research

This task is developed through a sequence of activities:

  - Identification of the challenges of each LLs through workshops.
  - Analysis of the information that need to be collected through the local partners.
  - Study and evaluation of the link between the PESTLE analysis, and the ISO 37101 standard and the DGNB certification.
  - Creation of a roadmap to support LLs through the challenges associated with the implementation of their GBNs.

1 Introduction

1.1 Mapping PROBONO Outputs

The purpose of this section is to map PROBONO's GA commitments, both within the formal Deliverable and Task description, against the project's respective outputs and work performed.

GA Component Title	GA Component Outline	Respective Document Chapter(s)	Justification
TASKS			
T1.4 GBN Transition Challenges, Enablers & Future Roadmap	Transition challenges, enablers & future roadmap The task links to T1.1 (for a detailed analysis of the relevant PESTLE framework components affecting development of GBNs. This task uses background (existing) and foreground (developed in project) knowledge. It is structured to best support decision makers understand how framework	Chapter 3	A detailed context analysis on a single LL aligned with what is expected in the Contextual Cycle Analysis. In the GA.
		Chapter 4	As all LL are expected, a synthetic comparison with the studied LL (Brussels) has been made. A global vision of the big differences with a detailed analysis has been made by local actors (LL managers)

	elements may impact different stages of the building lifecycle, from planning to end-of-life. Along with a transition roadmap of key milestones to be met towards the EU Green 2050 Vision. Contextual Analysis Cycle. Determine the framework for interweaving contextual elements into the GBN lifecycle, from planning to operation. Establish an iterative procedure for refinements and perform initial Living Labs analysis using a PESTLE framework. Link with T2.1 (T2.1 GBN and PROBONO innovation value chain stakeholder mapping and analysis [M6-M12]) for stakeholder concerns, and how this affects and influences the local context. Transition Challenges & Enabling Factors. Define the macro-environment enablers and challenges, and their integration in PROBONO. Using PESTLE, define areas to be considered. Perform initial analysis, and plan yearly refinements, that follow the stakeholders' engagement cycles plan (WP2). Use context analysis from T1.4.1 for the action plans definition and develop adaption strategies in line with the UN SDG's	Chapter 3 & 4	In each part, challenges have been identified from the context in which the LL is located. These challenges are detailed for the Brussels LL (chapter 3) and applicable to other LL. However, some challenges are not applicable or differ between Brussels and the others (chapter 4).
DELIVERABLE			
D17: GBN Transition Challenges, Enablers & Future Roadmap (I) This report formulates the findings of T1.4 and explores step/s A) Contextual framework created with known Challenges or enablers collated and adapted into LL Vision.			

Table 1: Adherence to PROBONO's GA Deliverable & Tasks Descriptions

1.2 Purpose and scope of the document

The present task is part of the PROBONO overarching effort to develop and promote GBNs across the EU. As such, it is feeding on the GBN framework that PROBONO is developing.

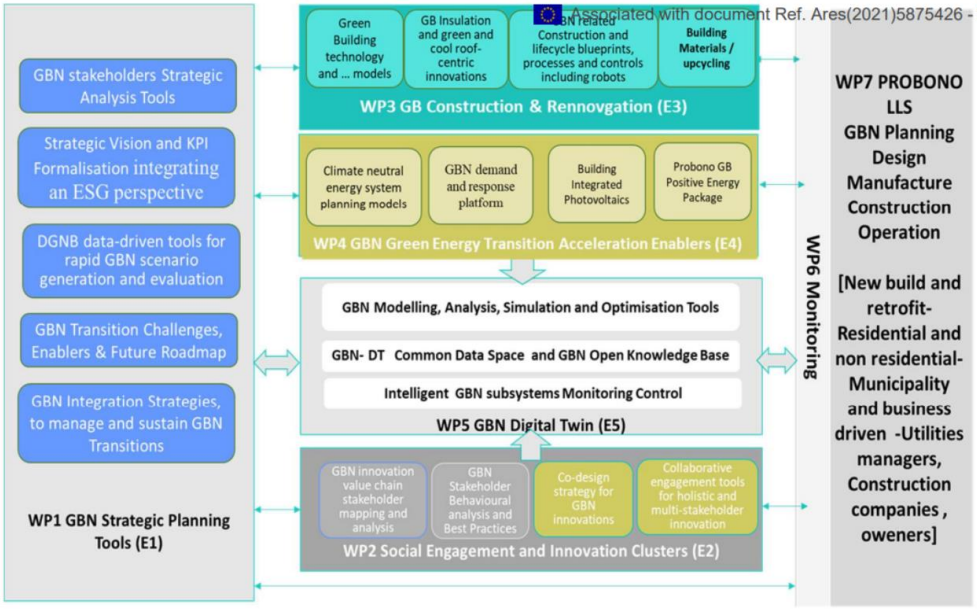


Figure 1: Overall Project Framework

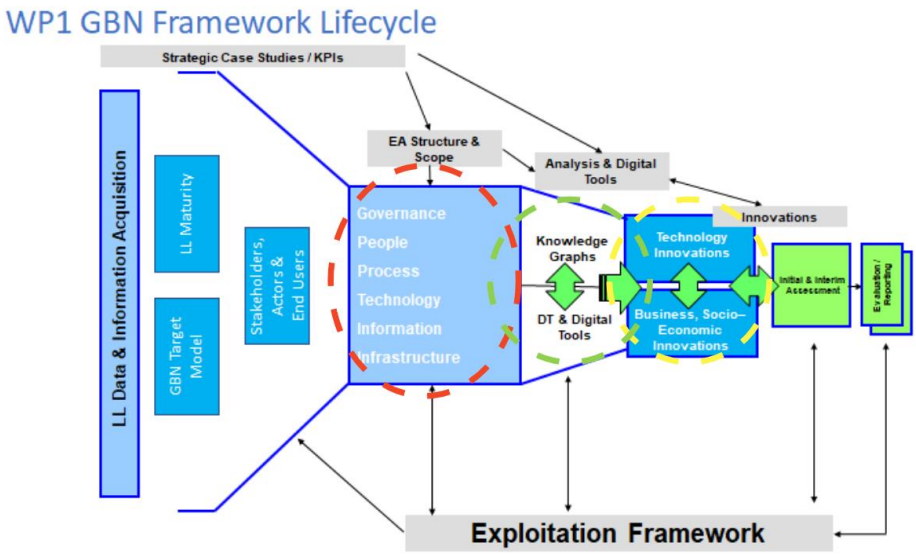


Figure 2: Our approach to GBNs

The aim of this report is to cover the first requirements defined in the PROBONO Grant Agreement (below noted as "GA") as follow:

- "T1.1: This task uses background (existing) and foreground (developed in project) knowledge. It is structured to best support decision makers understand how framework elements may impact different stages of the building lifecycle, from planning to end-of-

life. Along with a transition roadmap of key milestones to be met towards the EU Green 2050 Vision"

This document resonates with the 10 PRINCIPLES FOR EFFECTIVE ACTION of the Global Alliance for Buildings and Construction [10].

1.3 Deliverable Structure of the deliverable and its relation with other work packages/deliverables

As explained before, this deliverable highlights the different challenges regarding each LL on the PESTLE aspects. The idea is to take the Brussels LL as an example, and then to highlight the main difference with Brussel LL with other LLs. Therefore, this report is organized by focusing first on Brussels LL, then on each other living lab, one after the other and breaking down every challenge associated to the multiple aspects of the selected LL. To finalize, the report provides some elements based on PESTLE analysis of different resilience and rehabilitation case-studies in European countries, that could inspire the scale transition from the building to the GBN.

This report is related to the findings of T1.4, and explored steps A) Contextual framework created with known Challenges or enablers collated and adapted into LL Vision; B) updated plans following local context. analysis.

This report gives the first step of a methodology aligned with the DGNB certification and ISO 37101 - *Sustainable development in communities* standard. This will allow local actors with a good knowledge of the territory to make a PESTEL analysis which will then be used to enrich the reflections to be certified DGNB and ISO 37101 for the implementation of a GBN.

This report is in link with the ST1.4.1 and ST1.4.2.

The next deliverable will be an updated plans following local context analysis on M18. It will be completed with some periodic update (M28 and M36). The final deliverable for the T1.4 will be the final update and the creation of the future roadmap for each LL for the M45.

To work on this task, all the partners participated at 2 workshops (Results visible in Annexes) and the following elements were selected for the PESTLE Analysis:

10 https://globalabc.org/resources/publications/adaptation-building-sector-climate-change-10-principles-effective-action

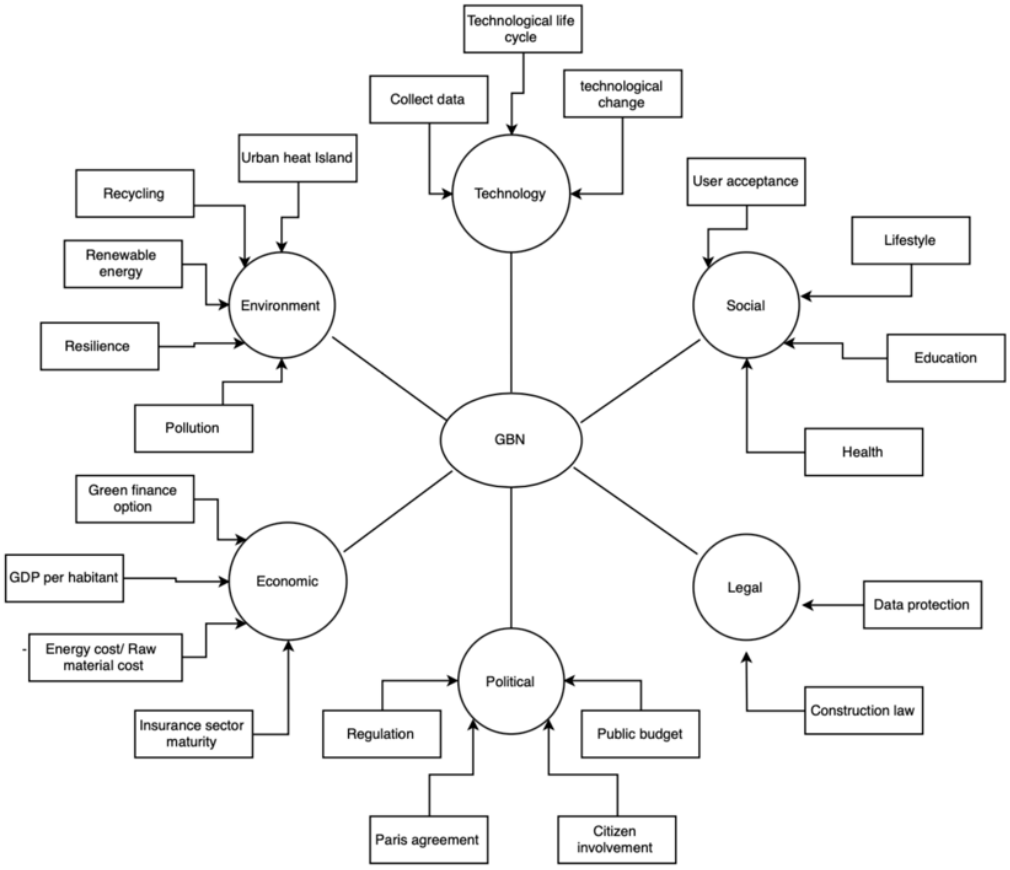


Figure 3: PESTLE Analysis

The PESTLE analysis is first and foremost a transverse review that analyses the framework in which the project is being carried out and makes it possible to identify the challenges that will be encountered and to classify it. That is why this analysis can be useful for all WPs and every partner of the PROBONO project.

This deliverable works in synergy with WP2 and task 2.1: GBN and PROBONO innovation value chain stakeholder mapping and analysis for stakeholder concerns, and how this affects and influences the local context. Indeed, for all the challenges identified in the PESTLE analysis, a stakeholder can be attached to it to then undertake actions with the right actors.

It is also a good input for the WP5 with a scoring (which will be developed throughout the PROBONO project) on the risks represented by the challenges identified in the PESTLE ANALYSIS that can be implemented into the DT.

Finally, this analysis will clarify the different WPs in the risks related to their task which necessarily touches one of the aspects of the PESTLE.

1.4 Contribution to the GBN concept

The PESTEL Analysis compiles political, economic, social, technological, environmental, and legal analysis of the context where each GBN will be implemented. In this way, this deliverable set out to deliver an in-depth context study at the GBN level but also support the GBN concept by apprehending the complexity of this this multifaceted concept into one tool.

The document highlights the variety of actors and challenges attached to each sector (political, economic, social, technological, environmental, and legal) demonstrating the impact that they can have on each GBN using severity score. This severity score also allows to identify the most critical challenges for each GBN and thus the highlighting of points of vigilance regarding the implementation of the GBN concept in each Living Lab.

2 Methodology of the PESTEL Analysis

2.1 Definition

Transitioning to a GBN requires a thorough understanding of the context in which the GBN operates. The implementation of a GBN is accompanied by technical challenges due to the innovative nature of the solutions that will be incorporated. Moreover, these technical solutions must be in perfect harmony with the lifestyle and societal issues of the inhabitants and users of the GBN. The environmental issues of circular economy, climate resilience or CO2 emissions mitigation over the entire life cycle of the GBN must be considered.

Finally, all this while respecting the legislation and policies of the countries and regions in which GBN is implemented.

It is thus quite naturally that a PESTLE analysis must be done to identify the risks that could compromise the proper implementation of a GBN.

Using the definition of the Washington States University:

A PESTEL analysis is a framework or tool used by marketers to analyse and monitor the macro-environmental (external marketing environment) factors that have an impact on an organization, company, or industry. It examines the Political, Economic, Social, Technological,

Environmental, and Legal factors in the external environment. A PESTEL analysis is used to identify threats and weaknesses which are used in a SWOT analysis.

- Political factors include government policies, leadership, and change; foreign trade policies; internal political issues and trends; tax policy; regulation and de-regulation trends.
- Economic factors include current and projected economic growth; inflation and interest rates; job growth and unemployment; labour costs; impact of globalization; disposable income of consumers and businesses; likely changes in the economic environment.
- Social factors include demographics (age, gender, race, family size); consumer attitudes, opinions, and buying patterns; population growth rate and employment patterns; socio-cultural changes; ethnic and religious trends; living standards.
- Technological factors affect marketing in new ways of producing goods and services; new ways of distributing goods and services; new ways of communicating with target markets.
- Environmental factors are important due to the increasing scarcity of raw materials; pollution targets; doing business as an ethical and sustainable company; carbon footprint targets.
- Legal factors include health and safety; equal opportunities; advertising standards; consumer rights and laws; product labelling and product safety.

This diagram realized by SpringWorks (a business consulting dedicated to help business owners, SMEs and start-ups) illustrates perfectly what is a PESTLE Analysis and the sub-themes that this analysis can take into account.

Figure 4: PESTEL explanatory diagram[11]

2.2 Application to the ISO 37101 Standard: Sustainable development in communities

The main goal of this section is the description of the PESTLE methodology that can be applied to any GBN. The approach adopted is inspired on existing international standardisation and sustainability assessment systems of districts and neighbourhoods, such as ISO Standards or the DGNB system. In this way, the methodology proposed brings multiple components regarding the sustainability of the GBN, in line with international certifications requirements.

The ISO Standards regroups a family of standards for sustainable, smart and resilience cities (see *Figure* ***5***), that support the PESTLE analysis of GBNs. More precisely, the *ISO 37101 - Sustainable development in communities*, establishes a set of requirements and guidelines to help communities become more sustainable, by achieving the Sustainable Development Goals (SDG). For this, a management system for sustainable development in communities is defined, an

11 https://springworks.ch/comment-conduire-une-analyse-pestel/

action plan is created, responsibilities are allocated and a system to measure performance is specified.

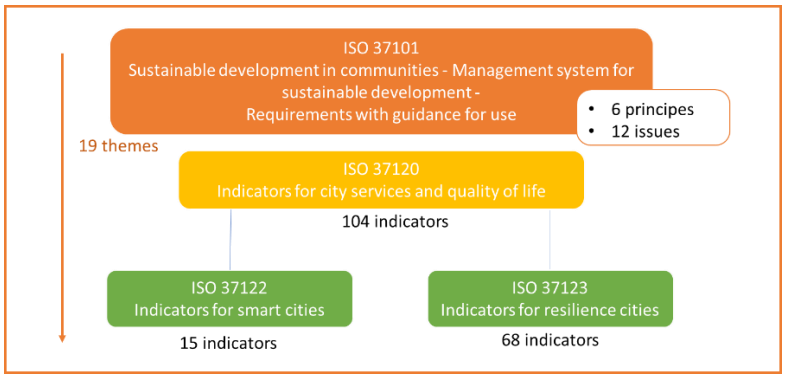


Figure 5: Sustainable cities and communities — Relationships within the family of city and communities indicators standards[12]

The requirements of the ISO 37101 are designed to be applied at any spatial scale (including neighbourhoods), at the community level by multi-actor structures, including citizens and local authorities. Besides, a sustainable development strategy for communities is defined through a matrix of six principles of sustainability and 12 issues/areas of action.

6 principles of Sustainability	12 issues of sustainability
• Resilience • Well-being • Responsible resource use • Social Cohesion • Preservation and improvement of the environment • Attractivity	• Governance, empowerment & engagement • Education & capacity building • Innovation, creativity & research • Health & care in the community

12 https://www.iso.org/obp/ui/#iso:std:iso:37123:dis:ed-1:v1:en

	• Culture & community identity • Living together, interdependence & mutuality • Economy & sustainable production & consumption • Living & working environment • Safety & security • Community infrastructures • Mobility • Biodiversity & ecosystem services

Table : Principles and issues of sustainability considered in the ISO 37101 assessment

This matrix allows in a coherent framework, to make a diagnostics and analysis of objectives and potential outcomes of the implementation of sustainable projects in communities, through the use of metrics and indicators.

More precisely, the *ISO 37120:2018 - Sustainable Cities And Communities- Indicators for city services and quality of life*, establish a set of 104 indicators to evaluate city services and quality of life and more precisely city's resilience planning and assessment, across 19 themes:

Figure 6: ISO 37120 themes. Source: WCCD, 2018.

The application & evaluation of the ISO let to identify additional indicators when evaluating smart and resilient cities. Therefore, two independent ISO standards are proposed:

- ISO 37122: 2019 - Sustainable Cities And Communities- Indicators for Smart Cities
- ISO 37123:2019 - Sustainable Cities And Communities- Indicators for Resilient Cities

The *ISO 34123- Indicators for Smart Cities* includes 15 indicators in the 19 themes documented by the ISO 37120, that consider "smart city" as a guiding concept in the sustainable development of cities (Schiavo, & Magalhães, 2022)13. Meanwhile, the *ISO 34123- Indicators for Resilient Cities* sets out a baseline of 68 indicators to evaluate the resilience on cites.

The United Nations Office for Disaster Risk Reduction (UNDRR) participates in the development of the norm ISO 37123:2019, which guaranty the alignment of the ISO with international norms, such as the Sendai Framework for Disaster Risk Reduction (a volunteer and legal agreement of UN member states to work towards reducing disaster risk). The ISO will also support multiple sustainable and resilience international agreement, such as the New Urban Agenda, the 2030 Agenda, and the Paris Agreement.

13 Schiavo, F.T.; Magalhães, C.F.d. Smart Sustainable Cities: The Essentials for Managers' and Leaders' Initiatives within the Complex Context of Differing Definitions and Assessments. Smart Cities 2022, 5, 994-1024. https://doi.org/10.3390/smartcities5030050

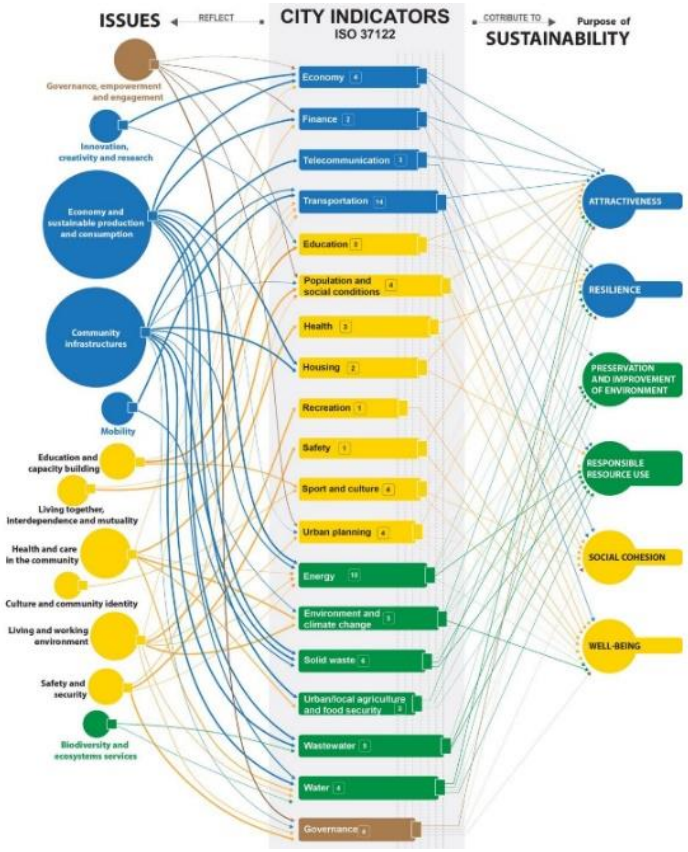


Figure 7: Indicators for smart cities in the ISO 37122. Source: Schiavo, & Magalhães, 2022.

The United Nations Office for Disaster Risk Reduction (UNDRR) participates in the development of the norm ISO 37123:2019, which guaranty the alignment of the ISO with international norms, such as the Sendai Framework for Disaster Risk Reduction (a volunteer and legal agreement of UN member states to work towards reducing disaster risk). The ISO will also support multiple sustainable and resilience international agreement, such as the New Urban Agenda, the 2030 Agenda, and the Paris Agreement.

2.3 Application to the DGNB Certification

The DGNB (Deutsches Guetsiegel Nachhaltiges Bauen) system is another standard/certification for sustainable districts/building projects, that can assist the PESTLE analysis of GBNs. More precisely, DGNB analyses the development of building projects with low CO_2 emissions in all their life phases, including planification, construction and exploitation. The principles taken into consideration in the evaluation of the sustainability in DGNB certification include:

1. Circular economy: Promotion of the reuse and the recycling of materials at the district level.
2. Citizens and people participation: Health and happiness of final users living in constructed environments is crucial point for decision making.
3. Design quality: Consideration of creativity and quality in design and construction of the sustainable building.
4. Sustainable development Goals: Integration of the SDGs in building projects
5. EU Conformity: Certification according to EU standards
6. Innovation: Sustainability of buildings and districts requires the integration of innovation areas that is continuously examining construction norms and task that allows the customization of projects.

This certification system considers 5 aspects/topics, which contains multiple individual criteria (40 sustainability criterion) for the evaluation of sustainable buildings:

1. Environment (6 criterion)
2. Economy (5 criterion)
3. Sociocultural and functional (8 criterion)
4. Technical (5 criterion)
5. Processes (7 criterion)

The DGNB evaluation is based on weighted factors allocated to each criterion. The DGNB system can be applied to five different urban schemes: urban districts, business districts, event areas, commercial areas, and industrial sites.

6 principles of Sustainability	5 aspects/topics of sustainability
• Circular economy	• Environment
• Citizens and people participation	• Economy
• Design quality	• Sociocultural and functional
• Sustainable development Goals	• Technical

6 principles of Sustainability	5 aspects/topics of sustainability
• EU Conformity • Innovation	• Processes

Table 2 : Principles and issues of sustainability considered in the ISO DGBN systems.

2.4 Link between PESTEL, ISO 37101 and DGNB Certification

Based on the ISO and DGNB system approaches, a specific evaluation framework is adopted for the GBN implementation, which is based in 5 aspects: Political, Economy, Social, Technological, Environmental and Legal. The PROBONO consortium identified 24 challenges associated with those aspects, which could positively or negatively impact the implementation of sustainability projects such as GBN. The results of the PESTLE analysis result in an appropriate support to understand the advancements of GBN, regarding the principles of sustainability in the framework of ISO 37120 or DGNB system standards.

The PESTLE analysis integrates a qualitative and quantitative analysis regarding the GBN implementation. This means depth background research is performed, to evaluate the impact of challenges for the GBN development projects, and how to address them. A literature review has to be performed to identify the importance of the challenge, its probability and consequence of occurrence, as well as the potential solutions and the actors involved.

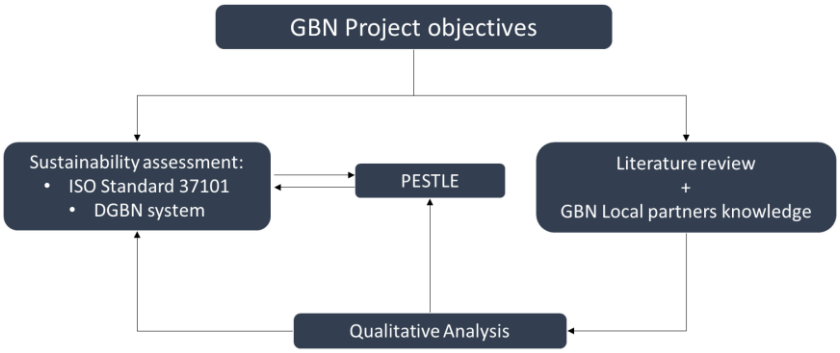


Figure 8: Link between PESTLE of GBN and sustainability assessment standards.

2.5 Example of application of the ISO 37101 in PRESQU'ÎLE-Grenoble:

The urban development project of PRESQU'ÎLE at Grenoble in France, includes several aspects of innovation such as: i) adaptable accommodations, service and leisure spaces to favouring the social mix; ii) increase the building energy performance through the application of the RT2012-30% law and the implementation of a geothermic network for building heath and cooling; and iii) mobility by the installation of pedestrian-friendly public spaces and a multimodal and adaptative approaches.

The application of the ISO 37101 management method for the PRESQU'ÎLE development project, included 5 steps review:

- *Ambition and Commitment*: It includes an overall governance and collaborative sprit, through the consultation with public and private local stakeholders and the dialogue with private landowners in the financing of the project.
- *Baseline Review*: Development of a preliminary urban diagnostic, which includes flood risk management, geothermic energy, and temperature regulation.
- *Strategy definition*: Given the quite local urban context, localization and potential influence in the urban planning and development of the city of Grenoble, the objectives of the project were stablished considered the following themes:
    - Preservation and enhancement of the geographical context
    - Public health and sanitation
    - Accessibility and promotion of the public transports
- *Implementation*: Delegated to interconnected stakeholders (usual actors such as investors or project carries, architects and engineering offices, construction firms, etc).
- *Evaluation*: From the design up to the implementation, the contribution of the project to sustainable development is evaluated.

The matrix of principles and issues of sustainability of the ISO 37101 was applied in this project. This allows to develop a hierarchization of the environmental objectives of the project. The priority objectives (red dots in the matrix) defined in PRESQU'ÎLE development project (marked as red dot in the matrix) were first marked in the matrix. Then, an inventory of recommendations

of the environmental charter depending on the purposes of sustainable development and areas of action were set up. Those recommendations are complemented based on brainstorm of local partners and revision of national or local prescriptive documents.

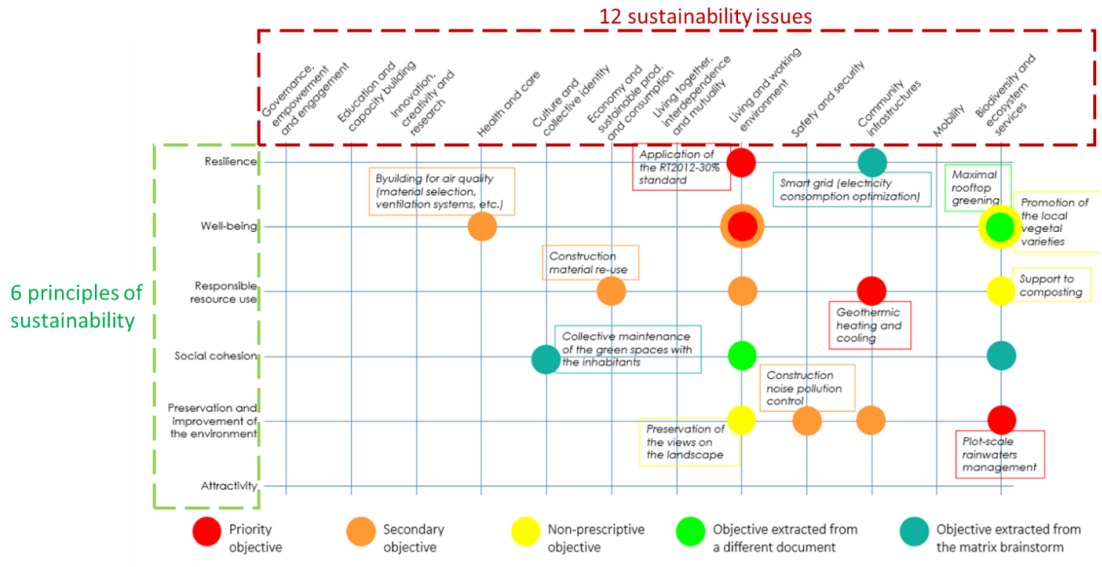


Figure 9: ISO 37101 matrix for Grenoble

Thus, the realization of a PESTLE analysis allows to have a sharp knowledge on the context in which the GBN is registered. The information collected is precious for applying it to the DGNB certification and ISO 37101 standard.

Here is an example of key information that can be collected during a qualitative PESTLE analysis.

3 Example of the Brussels Living Lab

In this 1st deliverable, we focus on the Brussels LL to establish the 1st methodology and the 1st detailed draft of a PESTLE analysis. Indeed, the small size of this LL compared to the other LL of the PROBONO project, and the specific population and context of the schools make this LL a good first case study. The other LLs will emphasize the big differences between their LL and the Brussels LL (see part 4).

For each item, we evaluated a risk severity score from 0 to 10 according to two criteria:

- The probability of occurrence (50%)

- The severity of the consequences on health, proper implementation of the GBN, respect of schedule, budget, etc. (50%)

This score is primarily qualitative and is not based on a certified method of calculation. It is primarily present to illustrate the importance of the challenge and to serve as an aid to decision making.

3.1 Introduction of the LL

The Living Lab building is De l'Autre Côté de l'Ecole (ACE) school building (Figure 4), home to a private school. Here is the description of the LL from the GA:

"ACE will be renovating 2000 m² out of their total school facilities to bring the areas into use for the educational needs of the school and in line with the latest environmental and regulatory requirements of the Green Deal. This renovation will also include transverse technical elements (roof, chassis, technical equipment, etc.)".

Figure 10: Brussels LL "De l'autre côté de l'école" in Auderghem

Participation in the PROBONO project is an opportunity to accomplish this transformation by meeting the highest standards of green innovation and the 2040 vision of the Brussels

Government grouped in four major themes: Mobilize the region to build the framework for regional development and create new neighbourhoods; Mobilize the region to develop pleasant, sustainable, and appealing living environment; Mobilize the region to develop its urban economy; Mobilize the region to promote multi-modal travel.

Location and climate: The Brussels Living Lab is located at Chaussee de Wavre 1789 (50.815770,4.429450) in the Auderghem Commune, in the southeast corner of the Brussels-Capital Region, Belgium. The climate is sub-oceanic, humid and rainy and is influenced by the close proximity of the Atlantic Ocean, with decently warm summers and cold, close to freezing temperature, winters. The wind blows frequently, and can be rather intense, especially in wintertime. Brussels does not get an abundance of sun, especially in the winter months. On average, Brussels counts of around 1,600 sunshine hours annually and has an annual average of 2,096 HDDs ad 60 CDDs.

Public/private business model and funding: ACE is a private school implementing the Feinet pedagogics. This being said, the Brussels Living Lab makes use of a combination of Public and *Private funding in reaching the project targets*. As an educator and a non-profit organization, becoming sustainable and supporting others in the neighbourhood to do so too is a solid business, economic and educational decision. Willis Towers Watson, one of the largest insurance brokers worldwide, leading on PROBONO's ESG, finance and investment tasks primarily in WP1, will play a part in assessing, analysing the financing and access to funding needs and opportunities of the Brussels Living Lab to complement where needed the traditional funding sources used by ACE. Historically ACE has carried out works in the school building with financial support from one of the three constituent constitutional linguistic communities, the French Community of Belgium the Wallonia-Brussels Federation.

3.2 Political aspect

3.2.1 Public budget

What kind of challenge?

- Why is it a challenge?

Historically, the school carried works with financial support from the French Community of Belgium the Wallonia-Brussels Federation. The question about the use of the financial support from the Wallonia-Brussels Federation is therefore emphasized.

As we know when financial support from a public entity is involved, the action taken with this money will need to be justified. Indeed, this money is part of the public budget and therefore is made to serve the public interest through this project.

- What is at stake?

The renovation of the De l'Autre Côté de l'Ecole (ACE) school building aims at making this Living Lab more sustainable through the modification of technical elements and improvements in several other areas to reach the standards of green innovation.

This transformation was thought to meet the 2040 vision of the Brussels Government based on the four pillars:

- Mobilise the region to build the framework for regional development and create new neighbourhoods.
- Mobilise the region to develop a pleasant, sustainable, and appealing living environment.
- Mobilise the region to develop its urban economy.
- Mobilise the region to promote multi-modal travel.

At a smaller scale, this project also aims at supporting the neighbourhood it is implanted in by providing high-quality education and being a high interest point when it comes to sustainable innovation in existing buildings in Belgium and across the European continent.

From this several point, the credibility of the project but also of the Wallonia-Brussels Federation financing this project is a stake. With money from the taxpayer being involved, the project must be successful in order to maintain the trust relationship between taxpayers and the Wallonia-Brussels Federation when it comes to money.

- What areas/activities/population are affected by this challenge?

This challenge puts the Wallonia-Brussels Federation and the De l'Autre Côté de l'Ecole school at the forefront for the reason that we explained previously. Indeed, in the unfortunate event of the failure of this project, both entities will be pointed at.

Then as a rippled effect, it will also affect the taxpayers by affecting their relationship with the Wallonia-Brussels Federation but possibly also with projects similar to this one.

As a consequence, the entire vision on the public system around the Wallonia-Brussels Federation might be stained.

- Risk severity: 6/10

Probability 2/10: The public budget is already defined and allocated for each year but there always is a chance that we might experience delay in the schedule that will lead to a complementary need of funds for the project or a modification in the public budget distribution in the coming years.

Consequences 10/10: The consequences of a problem regarding the public budget might impact and even block the entire development of the project.

Which actors will be involved, which actors we will have to contact for the implementation?

- Actors concerned by the challenge

As presented above, the Wallonia-Brussels Federation and the De l'Autre Côté de l'Ecole school are the main actors concerned by this challenge. Moreover, the civil society can also be involved through public consultations to promote the initiative through the community and ensure their adhesion to the project. This involvement can then have a larger ripple effect around the opinions about sustainable actions around the neighbourhood.

Now more precisely, we must focus on the specific actors that will have impact on the day-to-day progress of the project and therefore will have the large range of impact to ensure its smooth running. Moreover, the local authorities will also be involved with building license and advance notification.

- Actors who can bring a solution(s) to the challenges

When it comes to renovation works, a special attention is dedicated to construction details to ensure that the new elements added are properly insert in the existing building or that the existing elements are properly modified to match the new expected outcome.

Consequently, the actors that can bring solutions to the challenge of the smooth running of the project are the one directly doing the project:

- The architects and engineers designing the renovation plans.

- Construction consultants, suppliers and (sub)contractors implementing renovation plans.
- Renovation work managers (work/budget/schedule).
- Buyers/legal officials (lawyers) charged of the contractual part of the renovation works and watch over the budget.

- Actors with data/information

In this case, the actors with data and information are the same as the ones being able to bring a solution the challenge faced:

- The architects and engineers designing the renovation plans.
- Construction consultants, suppliers and (sub)contractors implementing renovation plans.
- Renovation work managers (work/budget/schedule).
- Existing data from local authorities.
- Existing data from ACE.

What possible solutions can we imagine at this step?

- Existing solution (developed elsewhere)

When it comes to the smooth running and success of construction work, project and work management are essential to ensure the respect of the works budget and schedule. Whether it is the management of resources, workforce, time and budget, a precise timetable should be design before the beginning of the work, in order to get the right structure in place with liabilities properly assigned. Also, during the running of the work, the timetable shall be constantly updated to be the most accurate possible.

- Ideas that can be explored.

Moreover, when it comes to management the concept of LEAN Management can also be accurate in this particular case. This specific approach supports the concept of continuous improvement during the term of a project. Such a concept could allow the project management for example to optimize its running by learning from every step back encounter during its course, eliminating any waste of time, workforce, resource and budget. Originally, LEAN Management

was mostly used in manufacturing works, but it is found more and more application around other fields such as construction work.

3.2.2 Paris Agreement

What kind of challenge?

- Why is this a challenge?

The Paris Agreement is a legally binding global climate change agreement that links today's policies and the goal of reaching climate-neutrality by the end of the century.

Through this document governments agreed to:

- "a long-term goal of keeping the increase in global average temperature to well below 2°C above pre-industrial levels"[14].
- "to aim to limit the increase to 1.5°C, since this would significantly reduce risks and the impacts of climate change"[14]
- "on the need for global emissions to peak as soon as possible, recognizing that this will take longer for developing countries"[14]
- "to undertake rapid reductions thereafter in accordance with the best available science, so as to achieve a balance between emissions and removals in the second half of the century"[14]

Therefore, cities, regions and local authorities aim to scaled up their efforts to minimize CO_2 emissions, develop resilience by reducing vulnerability to the effects of climate change and ensure cooperation among themselves. Following this initiative, each member state of the EU was required by the UE legislation to write a National Energy and Climate Plan (NECP) to ensure that the EU meets the set objective. In Belgium, the National and Climate Plan (NECP) covers[15]:

- Decarbonization

14 https://ec.europa.eu/clima/eu-action/international-action-climate-change/climate-negotiations/paris-agreement_fr

15 National Energy and Climate Plan 2021-2030 : Context, Objectives, Policies and Measures, 12/18/19, https://ec.europa.eu/energy/sites/ener/files/documents/be_final_necp_parta_fr.pdf

- Energy Efficiency
- Energy Security
- Research, Innovation & Competitivity
- Internal Energy Market

However, Belgium being a federal state, each federal entity (Wallonia, Flanders and the Brussels Capital Region) supplement its additional plan adapted to its specific context.

In the Brussels Capital Region, the Brussels Government committed itself through its Regional Policy Declaration on the following points [15]:

- The Region will adopt a long-term strategy based on binding objectives and an evaluation framework boxed by the Brussels Climate Ordinance.
- The Government aims at reducing by at least 40% greenhouse gases by 2030 compared to 2005.
- The Government will contribute as much as possible to the upgrading of the European Union's objectives.
- The Government is committed to approach the European goal of carbon neutrality by 2050.

Here, the Brussels Living Lab strives for participating in this dynamic by significantly reducing energy consumption and over a 5 years-time frame to cut CO_2 emissions in order to become a zero-emission building. In consequence, the challenge appears to be about successfully transitioning into a flagship building embodying the Brussels Region action into honouring the Paris Agreement.

- What is at stake?

Depending on how the project is presented to the press and supported by the public opinion, it can have more or less of an impact on how people perceive the Brussels Region's position about the Paris Agreement.

- What areas/activities/population are affected by this challenge?

Following what we stated above, the success or failure of this challenge will impact the image of the municipality within its own borders.

As we said, depending on the coverage of this project several scenarios can be expected:

- In case of success and large media coverage this project can put the Brussels Region and Belgium on limelight of climate change initiative with other the countries welcoming Living Labs.
- In case of success with a more moderate media coverage, this Living Lab can be presented as a Flagship project at a national scale and maybe be a pioneer project in school renovation sector.
- In case of failure, it can impact the Brussels Region and the country's inside and outside perception but can also be presented as a temporary setback depending on the narrative used to justified the non-meeting of the project deadline.

- Risk severity: 1/10

Probability 2/10: The project being aligned with energy efficiency and the reducing of CO2 emissions, it is therefore aligned with the Paris Agreement ambition too. A small uncertainty still lies in the proper use of the new equipment and their efficiency when installed.

Consequences 1/10: The non-respect of the Paris Agreement will not prevent the project to be completed.

Which actors will be involved, which actors we will have to contact for the implementation?

- Actors concerned by the challenge

The actors concerned by this challenge are the Brussels Region at regional scale but at the forefront, the first actor is actually the project management team (ACE, constructor, contractors, PROBONO teams in charge with this LL).

Again, as we stated the challenge here is for the project to respect the initiatives outlined in the Paris Agreement as becoming a zero-emissions building in the time frame of 5 years. Once the project stars, the largest range of actions in order to ensure the smooth running and the delivery of the expected outcome lands of project management.

- Actors who can bring a solution(s) to the challenges

Refers to 3.2.1.2 – Actors who can bring a solution(s) to the challenges

- Actors with data/information

Refers to 3.2.1.2 – Actors with data/information

What possible solutions can we imagine at this step?

- Existing solution (developed elsewhere)

Refers to 3.2.1.3 – Existing solution

- Ideas that can be explored

Refers to 3.2.1.3 – Ideas that can be explored

3.2.3 Citizen involvement

What kind of challenge?

- Why is this a challenge?

This project is partially funded by public budget and will be used by the inhabitants of the city it is implemented in. Naturally, those same inhabitants and public citizens should be involved in the process of the project. The real question is "How":

- At what stage of the project should they be involved in?

n/a

- How much should they be involved in?

When it comes to construction work and rehabilitation work in particular, the already existing relationship between the building and the public has to be taken into account in the project process through public consultations for example Should it be preserved? Should it change? How much of it should be modified? Is it possible? Numerous questions are bound to cross each other's in order to get a large and clear visualization of the complexity of those interactions.

Moreover, this project being an innovative one it will most likely implement brand new technology and concepts that the public is not necessarily familiar or comfortable with. Therefore, an adamant work shall also be made throughout the project and also during the first years after the delivery of the renovation work to guide the users into accommodating to this new type of building.

Thus, citizen involvement is crucial element of the implementation of Living Lab. From its conception to its use, it shall be centred around the user and by implication made with the user.

Following this line of thought everyone has its say but everyone being different, every citizen has a different say. A third question appears then "How to satisfy the citizens?"

- What is at stake?

What is at stake it not being able to realize a project appreciated and used by the public. The whole purpose of this Living Lab is to be used as a school first. However, the project should primarily be appreciated and supported by the population for them to then put their children into the facility.

Secondly, the project should be properly introduced to its future users in order to allow its daily use by them leading to the project being completely integrated and accepted by the ACE's team.

Indeed, what we want to prevent is an innovative initiative that does not fit its environment of application and is rejected by the people it was supposedly design for. That is why the involvement of citizen in the project should not be dismiss.

- Risk severity: 2/10

Probability 3/10: It is very unlikely that there will be no communication about this project with the neighbours or school community. However, a shadow still lingers on the reciprocity and weight of the communication linking the project initiators (person from whom the project idea originated) and project users.

Consequences 1/10: The consequences of an absent involvement of the citizen or non-effective one could create some negative talk around the project and could severely increase delays (ultimately it would lead to its blockage).

<u>Which actors will be involved, which actors we will have to contact for the implementation?</u>

- Actors concerned by the challenge

At the forefront, the actors impacted by this challenge will be the administration of the school and the local public authorities in truth, whether the school is accepted by the population after its renovation will directly affect them.

Naturally at the other hand of this challenge is the population, the citizen themselves. If they don't feel involved and possibly rejected this project, they will be left with a school they don't necessarily feel comfortable putting their children. Reasonably, it can be thought that the population will still put their children for education in the Living Lab but on an extreme measure it can be avoided that some people might entirely reject the project if they don't feel involved in its creation or at least taken into consideration in its design.

- Actors who can bring a solution(s) to the challenges

Here the actors that can bring solutions are at the core of the design of this project. Through the conception of the renovation projects and throughout the process of designing the plans, consultations with the public can be organized by the architects' team in order to get a clear vision of their needs, expectations and points of worries about this project.

Additionally, during the construction work informative meetings can be organized on a regular basis to keep the neighbourhood inhabitants informed of the running of the project. This action might participate in the feeling of the citizen being involved in the project and on the long run this can strengthen the link between the public and the to be created Living Lab.

- Actors with data/information

As the actors who are able to bring solutions to the identified challenge here, architects are also the ones holding the core data here being the design plans. However, the population are the ones here upholding the second part of the core data: their expectations. The two should now merge to create a project that also answer the expectations of the inhabitants of the neighbourhood it will be implemented in.

What possible solutions can we imagine at this step?

- Existing solution (developed elsewhere)

As presented previously, the architects' team can organize consultations with the population in order to ensure the effective communication of the project to the public but also to get feedback about the appreciation or the concerns about the needs of the inhabitants being met by the project. Furthermore, an effective communication about the project can be promoted through a website giving access to the update progress of the operations or a newsletter sent on a regular basis keeping the public to date.

- Ideas that can be explored.

n/a

Summary table

PESTEL ITEM	Category	Risk severity	Actors	Possible Solution
Politics	▪ Public Budget	6/10	▪ Wallonia-Brussels Federation ▪ Administration of the school ▪ Local Authorities ▪ Project Management Team	▪ Successful project Management ▪ LEAN Management
	▪ Paris Agreement	1.5/10	▪ Brussels Region ▪ Project Management Team	▪ Successful project Management ▪ LEAN Management
	▪ Citizen involvement	2/10	▪ Administration of the school ▪ Citizens	▪ Consultation with the public

Table 3: Summary table politic PESTLE

3.3 Economical aspect

3.3.1 Green Finance Option

Green finance refers to "any financial instruments whose proceeds are used for sustainable development projects and initiatives, environmental products and policies under the single goal of promoting a green economic transformation toward low-carbon, sustainable and inclusive

pathways" [3]. This includes investments to support an institution in its transition to a more sustainable model, which is exactly what the purpose of the renovation of the LL is.

What kind of challenge?

- Why is this a challenge?

In the context of a reliable access to fuel energy, green investments appear to be high-risk low-rate of return in most cases, which is not very appealing for any investors. However, we know that public policies are also being established to change this narrative. Indeed, in Brussels energy produced by photovoltaic panels can subsidised by the state, making it more appealing and enabling a return on investment on less than 10 years approximately. The government of Brussels Capital also put in place Green Certificates which are needed by electricity suppliers of the Region to label their business. Those certificates are correlated to the CO_2 savings made the electricity installation, therefore promoting greener alternatives like solar panels.

When it comes to green funded projects, the challenge lays on making them low-risk, and highly profitable for its investors.

From *Figure **11***[16], we can see that in order to stay under 1.5 degrees as stated in the Paris Agreement, climate finance will globally have to be supported by an investment between 1.5 to almost 4 USD Billions.

16 Green Finance Platform, Explore Green Finance, https://www.greenfinanceplatform.org/page/explore-green-finance

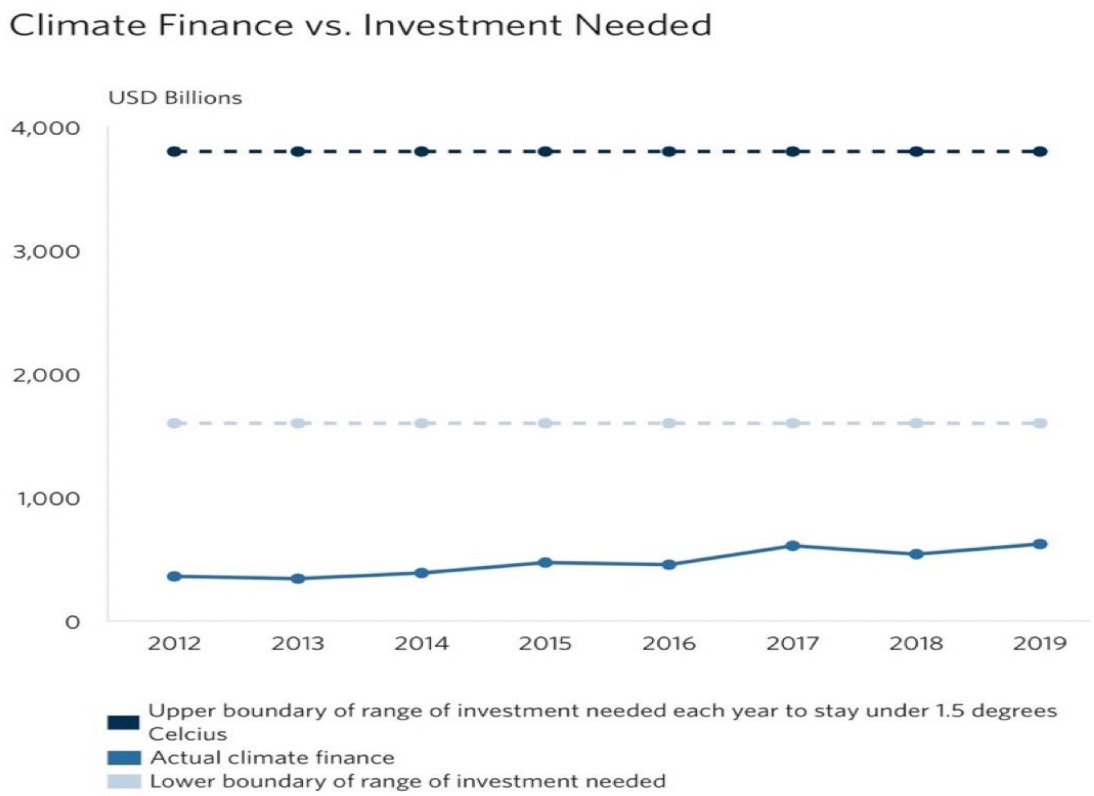


Figure 11 : Climate finance vs investment needed (source: Green Finance Platform)

However, the actual state of investments regarding climate finance reaches less than 0.8 USD Billion in 2018. Although, we can observe an increase between 2012 and 2019, it still is far beside the range of 1.5 USD Billion.

- What is at stake?

If the initial funds are not able to cover the costs of the project, external investment would be required. Although green funding is an option for the LL, the interest of the investors must be ensured. In case of impossibility of payment, it is necessary to be able to ensure the investors by mechanisms of guarantee.

- What areas/activities/population are affected by this challenge?

Firstly, the feasibility of the project is at stake. Without sufficient funding, the project might need to be downscaled and have lower performances in the long term. Making sure the LL receives the necessary funding ensures that we can proceed to everything planned.

Secondly, the investors need to make profit out of their investment in the LL. If they predict the investment would represent a loss of money, they won't invest at all. Furthermore, if there is low demand, the rate of interest will rise giving the LL a harder time paying up the investors.

This brings the need to make the project economically stable and guarantee the success and profitability (in the form of future savings).

Finally, if the project does get funding but cannot follow through on returning profit for investors, it will both hurt them financially, and hurt the credibility of the school.

- Risk severity: 6/10

Probability 2/10: In case of the initial funds not being enough, green financing could also be used to sustain the project. The amount raised should therefore be enough to compensate the required cost to complete the project.

Consequences 10/10: The consequences of a problem regarding the project budget might impact and even blocked the entire development of the project.

Which actors will be involved, which actors we will have to contact for the implementation?

- Actors concerned by the challenge

The actors concerned by this challenge are the project management team at a smaller scale and the countries that signed on the Paris Agreement on a larger scale. Indeed, as we saw there isn't enough investment made each year to stay under the 1.5 °C. As a result, the involvement and will of action of Belgium as a signing member of the Paris Agreement can be questioned and the initiative that may need those investments to fulfil their vision might be left in a position of lack regarding its finances.

- Actors who can bring a solution(s) to the challenges

Many different funding agencies, banks and lenders can provide solutions for the LL, at different scales, which can be studied under the lens of the chosen budget of the project. At a national level, funding can be found from Belgian agencies, or from other countries such as in Luxembourg, the Luxembourg Green eXchange (LGX) is a platform entirely dedicated to giving exposure to green bonds. Investment could also be found on a greater level, like from the European Investment Bank, that support ecological transition. Also, there could be a private and public funding agreement using local subsidies to support the project.

- Actors with data/information

The actors with data and information are also the funding agencies or investment banks. But the project management team should not be forgotten as they are the one with all the required information concerning the project.

What possible solutions can we imagine at this step?

- Existing solution (developed elsewhere)

As presented previously, funding agencies and investment banks can be a great alternative.

- Ideas that can be explored.

In order to get the best funding option, all risks must be assessed and minimized beforehand, and we need to be able to guarantee in advance that other challenges will be solved as much as possible.

3.3.2 GDP per habitant

Belgium's GDP per capita evolves like those of other high-income countries, at an annual growth rate of around 2%.

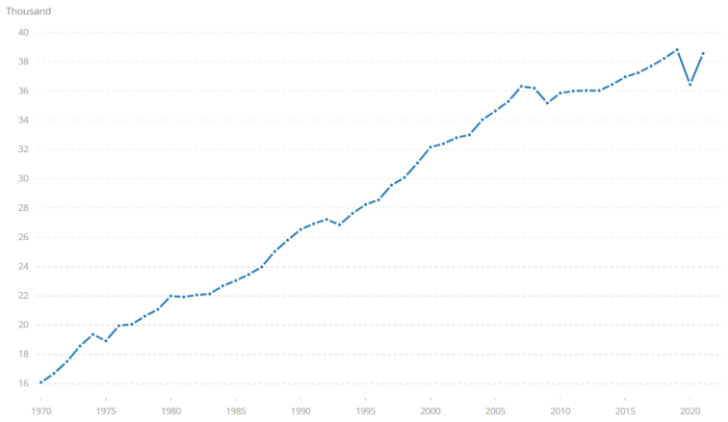


Figure 12:GDP per Capital (Constant LCU - Belgium (Source: World Bank) [17]

As presented on figure 6, the GDP per capita evolved from 16 000 in 1970 to almost 40 000 in 2020. Like other countries, Belgium was also particularly affected by the health crisis of 2020.

17 The World Bank, GDP per capita (constant LCU), https://data.worldbank.org/indicator/NY.GDP.PCAP.KN

Similarly, just like other countries the evolution of the Belgian GDP will most likely be affected by climate change. Indeed, the Swiss Re Institute stated that one of the biggest impacts of a rise of temperature by 3.2°C by 2050 could lead to a decrease of 18% of the GDP of the worldwide economy by the same year [18].

What kind of challenge?

- Why is this a challenge?

Since the target of the project is the very place where many people work, it is important to ensure an improvement in the quality of life and standard of living of these people. Since the LL depends on subsidies from the Wallonia-Brussels Federation, the country's wealth and the priority of education in the budget directly determine the resources available to the school for its future projects and workers' salaries. As the Wallonia-Brussels Priority Education Zones have been replaced by other decentralized measures, the LL cannot expect to represent a priority education institution for investment from the federation.

- What is at stake?

Acknowledging that the link between GDP and public funding is not a direct one, the lack of public funding for the LL threatens the proper functioning of the school and is likely to lead to downsizing, driving out both pupils and staff. Indeed, the GDP of the country is decreasing and the economical state is worsening, the funding allocated for this project might be reduced leading to a downslading of it.

- What areas/activities/population are affected by this challenge?

The evolution of GDP per habitant is a way to measure the level of development of a country nut also to assess its inhabitants' standard of living. It concerns the way of life of the whole population, especially the active population. In the case of the city of Brussels, 57.2% of the population is active, which is a little less than the regional rate of 59.0%. Among the active

18 Natalie MARCHANT, "This is how climate change could impact the global economy", WORLD ECONOMIC FORUM, Article, June 28th 2021, https://www.weforum.org/agenda/2021/06/impact-climate-change-global-gdp/#:~:text=The%20largest%20impact%20of%20climate,the%20Swiss%20Re%20Institute%20warns.

population, 22.4% live with a minimum wage or another source of allowance (unemployment benefit, disability benefit)[19].

- Risk severity: 4.5/10

Probability: 3/10: The GDP situation might indeed influence the repartition and the amount of subsidies given by the Wallonia-Brussels Federation to this type of project. However, it is unlikely for the GDP to drastically change during the project development duration.

Consequences 5/10: The consequences of a problem regarding the project budget might impact and even blocked the entire development of the project or lead to more loans in order to complete the initial project.

Which actors will be involved, which actors we will have to contact for the implementation?

- Actors concerned by the challenge

The GDP is an index measured over the activity of the whole country, involving many actors that can influence its value, the main ones being firms, households, public institutions, non-profit institutions serving households, and other countries (through trade).

- Actors who can bring a solution(s) to the challenges

This is quite a political problem as the level of quality of life of the people in contact with the living lab will depend on the Federation's budgetary policy regarding education, subventions, and how it will evolve with climate change, as new priorities are likely to come up and the LL may face a shortage of resources.

- Actors with data/information

These questions are about macroeconomy, so experts in this field may be able to provide information and perhaps solutions.

What possible solutions can we imagine at this step?

With the effects of climate change, technological and sanitary crisis being more and more apparent nowadays; it appears those aspects should be considered when thinking about factors

19 Fiches communales d'analyse des statistiques locales en région bruxelloise – Fiche n°4 commune de Brussells-Ville https://www.ccc-ggc.brussels/sites/default/files/documents/graphics/fiches-communales/2010/04_Brussells-vlle_fr.pdf

that are threatening the world economy. Therefore, it is important that each country developed strategy to ensure the resilience of their economy (population and infrastructures) against these hazards.

3.3.3 Energy cost/raw material cost

What kind of challenge?

- Why is this a challenge?

With the increase in demand for renovation materials, the energy transition, and various crises such as the war in Ukraine heavily influencing prices, energy and raw material prices are exploding and will probably continue to rise. The initial project's budgeting and sizing might therefore not be as accurate as there once were.

- What is at stake?

It is by defining this issue that the renovation project will generating savings in the form of future energy costs reduction. Maximizing these savings increases the project bankability and hence profitability of the investments. The degree of accuracy in forecasting these savings minimizes the risk surrounding the investment and therefore makes it easier to be financially attractive.

- What areas/activities/population are affected by this challenge?

Naturally, energy and raw material producers as well as consumers will be affected by the price increase. The choices made for the materials used for the renovation will also affect the building of the LL, and all the people attending inside, both in terms of health and security.

- Risk severity: 9.5/10

Probability 9/10: When the energy crisis happening at the moment, the initial project's budgeting and sizing might therefore not be as accurate as there once were.

Consequences 10/10: The consequences of a problem regarding the project budget might impact and even blocked the entire development of the project.

Which actors will be involved, which actors we will have to contact for the implementation?

- Actors concerned by the challenge

The actor concerned by this challenge is the project management team.

- Actors who can bring a solution(s) to the challenges

The actors that can bring a solution to this challenge are economists of the construction sector. They might be more inclined to guide the project manager on questions and choices regarding energy cost and raw material cost. Moreover, the take of energy efficiency experts on the matter should also be taken into consideration.

- Actors with data/information

The actors with data and information are also the economists of the construction and the energy efficiency experts for the same reasons exposed above. In addition, we must also include the school administration and the project management team as they are the one in possession of the construction's information and the budget available for the whole enterprise.

What possible solutions can we imagine at this step?

- Existing solution (developed elsewhere)

Price projections can be used to perform benefit/cost analyses to assist in the decision-making regarding choices on material for the construction.

- Ideas that can be explored

n/a

3.3.4 Insurance sector maturity

What kind of challenge?

- Why is this a challenge?

We focus in this section on climate resilience related risks, as we deem the business-as-usual risks to be well covered within the school, who has been operating for some time. Even after the renovations, the LL will most likely be exposed to environmental hazards (e.g. urban heat island, urban flood, etc) with an increasing intensity and frequency due to climate change. In the event of a disaster, the damage cost wouldn't be planned and would need to be covered as fast as possible, which brings the need for an insurance. Since 2006, Belgian law provides that the fire insurance contract also covers damage caused by a flood, landslide, subsidence or earthquake. However, insurance contracts typically only take into account exposition and not

vulnerability, which means increasing resilience to climate change does not necessarily mean negotiating a better insurance contract. What is at stake?

It is non-negotiable that the building must be insured against natural disasters. Choosing a good insurance policy ensures that the LL has the means to repair the damage in case of a disaster without having to resort to an additional financing / loan. Without this insurance, the building is exposed to financial risks that jeopardize the sustainability of the project.

- What areas/activities/population are affected by this challenge?

In the event that the LL is damaged enough that it can't function properly, staff and students will need to find alternatives which will affect other local schools as well. The insurance is a way to ensure the building can function again as soon as possible.

- Risk severity: 5/10

Probability 5/10: The risk depends on the exposition and vulnerability of the building to environmental hazards. As we need a larger assessment to evaluate those, we will put the probability of 50% in the first version of this document.

Consequences 5/10: The consequences of a natural hazard can also differ largely. From a deeper assessment of the natural hazards likely to threaten the project, we will also be able to better assess their consequences. As for now, we will also put the probability of 50% in the first version of the document.

Which actors will be involved, which actors we will have to contact for the implementation?

- Actors concerned by the challenge

This challenge involves the insurance companies, who will cover the costs of the damage in case of an accident, the LL, who will suffer direct consequences from the damage and the Wallonia-Brussels Federation, since it may be the entity that intervenes should the insurers' intervention limit be reached though it has yet to happen ever since it is part of the Belgian law [20].

- Actors who can bring a solution(s) to the challenges

20 https://economie.fgov.be/fr/themes/services-financiers/assurances/incendie-et-catastrophes/autres-risques-assures/risques-obligatoires/risques-obligatoires

The insurance contract is the parameter for this challenge. So, the only actors that can directly bring change to this situation are the insurance companies and/or an insurance broker if there is one for the LL actors with data/information.

Similarly, the actors with data and information are also the companies from the insurance sector. However, they could rely on climate change experts to back their updated data.

What possible solutions can we imagine at this step?

- Existing solution (developed elsewhere)

The insurance sector is increasingly taking into account climate change effects as disasters because of the phenomena that we are experiencing now regularly around the globe.

- Ideas that can be explored.

As we continue to ensure the resilience of the project to climate change, technological and sanitary challenges, we also need to be more accurate about the costs this phenomenon but also of the solutions we might implement to oppose them. Indeed, this cost analysis is the next step to obtain a defined, adapted and feasible resilient project.

Summary table

PESTEL ITEM	Category	Risk severity	Actors	Possible Solution
Economic	▪ Green Finance	6/10	▪ Project Management Team	▪ More funding agencies and Investment Banks dedicated to financing green initiatives
	▪ GDP per habitant	4.5/10	▪ Population	▪ Each country should do its own assessment of the impact climate change could have on its economy in order to find a way to

				ensure its thrive through this transition
	▪ Energy/ Material cost	9.5/10	▪ Project Management Team ▪ Economist of the Construction	▪ Price projections can be used to perform benefit/cost analyses to assist in the decision-making regarding choices on material for the construction
	▪ Insurance sector	5/10	▪ Insurance companies ▪ School administration ▪ Wallonia-Brussels Federation	▪ The insurance sector is more and more taking into account climate change effects as disasters

Table 4: Summary table economic PESTLE

3.4 Social aspect

3.4.1 User acceptance

What kind of challenge?

- Why is this a challenge?

The challenge here is to ensure the user will accept and embrace the renovation project as it will be designed for them. This situation might be challenging because of the innovative aspect of the project, making it new to the people that will have to use it.

- What is at stake?

What is at stake here is an abrupt rejection of the project by its user or possibly a slower non acceptance of the project. The latter option might be experienced into few and fewer people involving themselves in the Living Lab throughout the years. Also, for the people in charge of the maintenance of those technical implementations, it shall also be ensured that they are properly introduced to this new technology.

- What areas/activities/population are affected by this challenge?

This challenge is equally affecting the administration of the school and the parenting population of the neighbourhood. In the face of a rupture between what the school is proposing as an education facility and what the parents are wishing to get for their children, we can get into a situation where both parties are left without their needs being met.

- Risk severity: 2/10

Probability 2/10: The probability of the school users or the school maintenance rejecting this project is very thin as it is not a controversial one. However, it still is needed for the project to be properly introduced to all parties to ensure its success.

Consequences 2/10: The consequences in case of user unacceptance will not be very impactful as it can be modified through conversations and communications between parties. And moreover, it won't effectively block the project from happening.

<u>Which actors will be involved, which actors we will have to contact for the implementation?</u>

- Actors concerned by the challenge

Refers to 3.2.3.2 – Actors concerned by the challenge

- Actors who can bring a solution(s) to the challenges

Refers to 3.2.3.2 – Actors who can bring a solution(s) to the challenges

- Actors with data/information

Refers to 3.2.3.2 – Actors with data/information

<u>What possible solutions can we imagine at this step?</u>

- Existing solution (developed elsewhere)

Refers to 3.2.3.3 – Existing solutions

- Ideas that can be explored.

Additionally, to consultations with adults, children might also be consulted as future primary user of the school. What would they want to see in their education facility? What kind of school are they dreaming of? Those new propositions might lead to new perspectives to consider when it comes to the design of the renovation project.

3.4.2 Lifestyle

What kind of challenge?

- Why is this a challenge?

For the viability of this project through time, we must ensure that it matches the existing lifestyle of the neighbourhood it will be implemented in or at least do not abruptly disturb it.

- What is at stake?

Again, what is at stake here is the integration of the renovation project in an existing environment. How can we ensure that this happen in smoothest possible way? How can ensure that this renovated project won't over polluted the area with extra CO2 emissions, noise and light for example? Naturally, the modification of element of the neighbourhood will create changes but how can we ensure that this change is still aligned with the existing lifestyle of the area?

- What areas/activities/population are affected by this challenge?

The ones affected by this challenge are the population living in a close range to the renovated building. Moreover, the people working or going to the school daily will also be affected by this change but in another way: this perspective is covered in paragraph 3.4.1.

- Risk severity: 1.5/10

Probability 1/10: The probability of the project disturbing the existing lifestyle of the neighbourhood is quite low as the project was thought more to sustain an existing lifestyle trough energy efficiency rather than disturbing it.

Consequences 2/10: If this case, the consequences will mostly be complaints and maybe petitions. But nothing effectively threatening the project from happening.

Which actors will be involved, which actors we will have to contact for the implementation?

- Actors concerned by the challenge

The actors concerned by this challenge are firstly the school administrations but also the designers of this project and thirdly the public administration. Indeed, in the supposition of the renovated project interfering too much with the existing lifestyle, the neighbours will probably first contact the school administration to complain. Then, in case of furthers complains the architects might be requested to explain their design choices and justify it. Further down the line, the public administration might also be blame for allowing a project that disturb the lifestyle of the inhabitants of the area.

- Actors who can bring a solution(s) to the challenges

The actors that are able to bring the solutions to this challenge are the architects through the adequate design of the renovation. But their actions must be supported by consultations with the neighbours for the process to be successful. Indeed, it will take the neighbours and the designers to work together to be able to fulfil the renovation vision in an existing environment.

Moreover, the management of the construction works should not be neglected. Building's renovation works can create a lot a noise, waste and even pollution or traffic jams. Therefore, the neighbours should also be informed and prepared about how their routine might change during the construction process too.

- Actors with data/information

The actors with data and information here are the projects designers and the population of the neighbourhood.

<u>What possible solutions can we imagine at this step?</u>

- Existing solution (developed elsewhere)

Solutions on this challenge mostly rely on collaboration between the project designers and the neighbourhoods' inhabitants through physical meetings, online meetings or maybe an open letter box to get messages or requests. The goal with those actions is for each party to hear the side of the other one. Naturally in reality, those situations don't necessarily goes as planned but they might at least allow the flow of information between both parties

3.4.3 Education

What kind of challenge?

- Why is this a challenge?

The challenge here leans on the education provided by the school. Will the education program and the school availability morph with the renovation of the building? If yes, how can we ensure that the parents' expectations when it comes to their children's education are being met through this transition?

- What is at stake?

The relationship between the parents and the school administration is here at stake.

- What areas/activities/population are affected by this challenge?

Therefore, the pupils' parents and the school administration are the ones being the most affected by this challenge.

- Risk severity: 1/10

Probability 1/10: In this case, the education program is not likely at all to morph with the renovation project as the renovation project does not have any direct influence on the school program.

Consequences 1/10: The consequences in case will not very impactful as it can be modified through conversations and communications between parties. And moreover, it is unlikely that it will effectively block the project from happening.

Which actors will be involved, which actors we will have to contact for the implementation?

- Actors concerned by the challenge

The actors concerned by this challenge are the pupils' parents, the school administration and possibly the public administration too if the relationship between the first two actors is completely broken: the parents' pupil might point out the public administration as an authority instance.

- Actors who can bring a solution(s) to the challenges:

The actors able to bring solutions this challenge is the school administration. Firstly, because they are the ones having the upper hand about the way they will implement the educational program but also because they are one directly in contact with the pupil's parents.

- Actors with data/information

Similarly, the actor with data concerning the educational program is the school administration.

What possible solutions can we imagine at this step?

- Existing solution (developed elsewhere)

In case of the modification of the school program in its core or in its implementation due the project renovation, a proper spread of those additional information to the pupils' parents shall be ensured. Whether it is through physical meetings, online meetings, newsletters or mail, communication between both parties is crucial here too.

- Ideas that can be explored.

n/a

3.4.4 Health

What kind of challenge?

- Why is this a challenge?

With the recent pandemic, there is an emphasis on health as a core criterion when it comes to buildings design. How can we ensure that the building preserve the health of its users and/or is adaptable enough in case of a crisis as the COVID 19 one?

- What is at stake?

The challenge here is to respect and preserve the health of the Living Lab's users when being in the building but also renovation workers and the neighbours while proceeding to the renovation work. Indeed, constructions work can be polluting for the environment it is located in, but it can also lead to accident endangering the construction workers on the site.

- What areas/activities/population are affected by this challenge?

The population affected by this challenge is first and foremost the teachers and pupils of the school as they will be the ones in the Living Lab on a daily basis. Similarly, the construction

workers will also be on site during the entire duration of the construction works and their health should therefore be equally considered. Additionally, the neighbours might also be affected by this project and their health should also be thought of.

- Risk severity: 5/10

Probability 4/10: The probability to be face with health issues in school are high. Similarly, the challenge of containing their spread whether it is a flu or COVID 19 is as much high. Moreover, health hazards can also happen during the construction phase and should be watched out for. However, measures should have been established to avoid that.

Consequences 6/10: While health issues than happen after the construction work is done won't have an impact on its completion, health issues or hazards than happen during the construction phase might cause delays and therefore seriously impact the project.

Which actors will be involved, which actors we will have to contact for the implementation?

- Actors concerned by the challenge

The first actor concerned by this challenge is the school administration as they are in charge of the pupil's safety and therefore health too in the limits of the school buildings. Secondly, the project designers are also concerned by this challenge as they oversee ensuring the respect of health conditions in their renovation project. Finally, the project management team has the responsibility of ensuring the health and safety of the construction workers on site.

- Actors who can bring a solution(s) to the challenges

From the actors concerned by the challenge, two of them can actually bring a solution to the challenge:

  - The architects have the range of action on the renovation project's plans and therefore can take into account health preservation into their plans.
  - The project management team can also take specific measure to ensure the safety and health of the construction workers but also of the neighbours around the construction site.

- Actors with data/information

Here, the actors able to bring a change are also the one with key information and data.

What possible solutions can we imagine at this step?

- Existing solution (developed elsewhere)

To ensure health during the duration of the renovation work, safety measures can be taken on the construction site to avoid any accidents with workers, any pollution through chemicals and waste of the site but also the surrounding environment. All those measures are requested for High Quality Environmental construction work.

Furthermore, when it comes to ensuring health in the building, measures are also listed for High Quality Environmental buildings. And from the experience of the Covid 19 pandemic, new measures are being explored and presented to the public to apply to all buildings.

- Ideas that can be explored.

Summary table

PESTEL ITEM	Category	Risk Severity	Actors	Possible Solution
Social	▪ User acceptance	2/10	▪ Project Management Team	▪ Consultations with the school users and maintenance team
	▪ Lifestyle	1.5/10	▪ School administration ▪ Project designers ▪ Public administration	▪ Ensuring public consultations, and communication channels between the site users and the school administration but also with the neighbourhood

PESTEL ITEM	Category	Risk Severity	Actors	Possible Solution
	▪ Education	1/10	▪ School administration ▪ Pupil's parents	▪ Ensuring communication channels between the school administration and the pupil's parents
	▪ Health	5/10	▪ School administration ▪ Project designers	▪ Respect of safety measures and health standards

Table : Summary table social PESTLE

3.5 Technological aspect

3.5.1 Data management

What kind of challenge?

- Why is this a challenge?

As mentioned above, data collection is one of the 5 main parts of the DT and is the most cross-cutting part. This question of identifying data collection challenges raises several issues around:

- The type of technology to use
- How to collect the data?
- How often to collect the data?

First of all, with regard to the type of technology, based on a study about the technologies enabling digital twins [21], we distinguish the following categories of technologies that will be used in the digital twin:

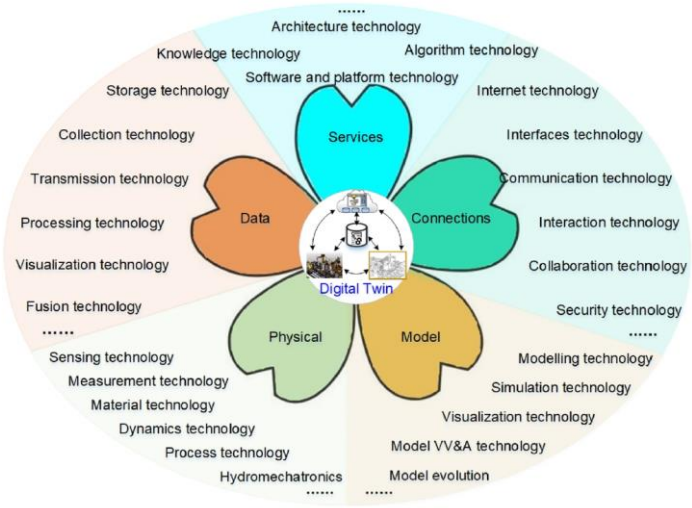


Figure 13:Framework of technologies enabling digital twins[21]

In this collect of data on the real characteristics, we distinguish the data concerning the knowledge of the intrinsic characteristics of the building and the data allowing to make monitoring and to follow the quality control processes of the building. Each of these data traces the real through the virtual model21.

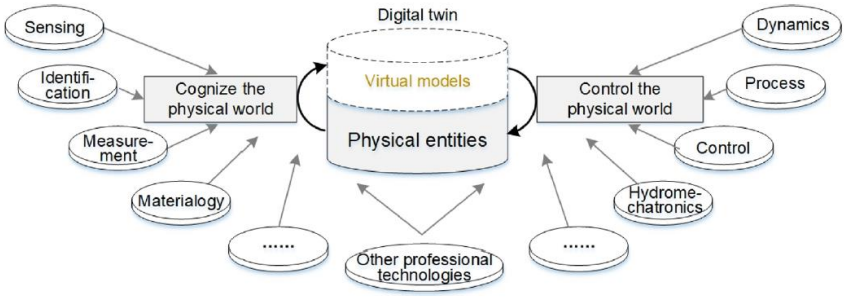


Figure 14:Digital twin virtual model [21]

Thus, each technology chosen will have to be used to either:

- Collect data

21 QinglinQi ; FeiTao ;TianliangHu ;NabilAnwer ; AngLiu ; YongliWei ; LihuiWang ; A.Y.C.Nee : Enabling technologies and tools for digital twin : Context, Objectives, Policies and Measures, 10/01/19, https://www.sciencedirect.com/science/article/abs/pii/S027861251930086X

- Transmit data
- Store data

The collection of data from the physical world is essential since it is this data that will be used to make the simulations done in the virtual world consistent for the management of LL.

- What is at stake?

Therefore, we conclude that the collection of data from the physical world is essential since it is this data that will be used to make the simulations done in the virtual world consistent for the management of LL Thus, if the sensors are no longer working properly, the DT is directly impacted with false or missing data. The DT becomes unusable.

- What areas/activities/population are affected by this challenge?

The affected sectors are multiple because the data concern all levels of DT use.

Indeed, there are:

- The municipality
- The state
- LL managers (public or private)
- The residents/users of the LL
- The energy suppliers
- The European Commission in the framework of the PROBONO project
- The partners of the PROBONO Project

- Risk severity: 7/10. (Average between Probability and Consequences below)

Probability 4/10: The technology is mastered, and the software and servers are operated, maintained and in place for a significant period.

Consequences 10/10: The less data is collected and present, the less accurate the simulations created in the virtual world will be. Thus, it is possible to accept a certain amount of missing data. However, if there is too much missing data, the confidence index of the virtual world simulations will not be high enough and the use of the DT will be useless. However, the data collected in the GBN is sometimes private. A data leakage following a cyber-attack leads to a risk of loss of trust of citizens towards the GBN and thus a significant risk in the implementation of

the GBN. Because GBN cannot be implemented in an environment where local actors are not convinced.

Which actors will be involved, which actors we will have to contact for the implementation?

- Actors concerned by the challenge

As far as data is concerned, everyone is a user but also an actor of data. It is therefore natural that we find the same actors as those involved in the "data management" challenge, i.e:

  - The municipality
  - The state (during the R&D phase)
  - The LL managers (public or private)
  - The residents/users of the LL
  - The energy suppliers
  - The European Commission in the framework of the PROBONO project (during the R&D phase)
  - The partners of the PROBONO project.

- Actors who can bring a solution(s) to the challenges
  - Suppliers of sensors, visualization software to be chosen in WP5.
  - See *Figure **15***
- Actors with data/information
  - LL managers
  - The municipality
  - The state
  - Europe Union
  - The actors of PROBONO

What possible solutions can we imagine at this step?

- Existing solution (developed elsewhere)

Here the following existing solutions in terms of management and visualization of the collected data [8]:

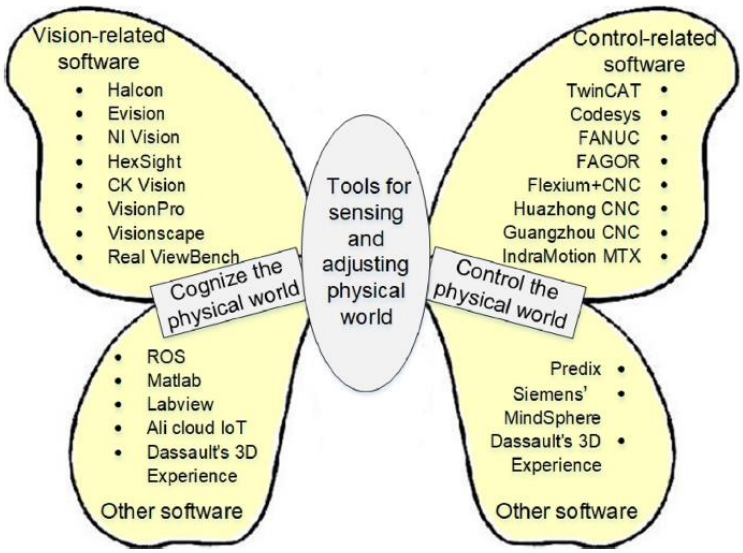


Figure 15:Management of the collected data [21]

Many IOT sensors exist to measure temperature, movement, fire risk, etc. These connected sensors can communicate with the chosen management and visualization software. The communication can be done by Wi-fi, GSM network or LoRaWAN (radio telecommunication protocol allowing the communication of connected objects at low speed).

For example, the company Enless Wireless, a specialist in sensors, has produced this product with a lifespan of 15 years.

Figure 16:Wireless Sensor[22]

22 https://enless-wireless.com/fr/products/transmetteur-de-temperature-avec-capteur-integre-2/

- Ideas that can be explored

The idea is to explore solutions corresponding to the world of the building specifically, as the following ones[23] :

Technology	Hardware	Common applications	References
Electronic location and distance measurement	Robotic total stations, range finders, and so forth. Laser scanning	Record current state of construction	Brilakis et al. (2010), Han and Golparvar-Fard (2017), Yang et al. (2015)
Global Positioning System (GPS)	Differential GPS readers	Locate and measure work done; track production progress	Ergen et al. (2007)
Computer vision (stills and video)	Video, stills, 360° images	Safety; production progress; labor; and equipment	Luo et al. (2018), Seo et al. (2015)
Audio and sonar	Microphones	Identify equipment function and use	Compare Cheng et al. (2017), Lee et al. (2020)
Tag identification systems	Bluetooth Low Energy (BLE), radio-frequency identification (RFID), barcodes	Track materials; worker locations and durations; quantity and quality	Park et al. (2016), Zhao et al. (2019)
Communication networks	Wi-Fi, ultra-wideband (UWB), cellular	Material tracking; worker locations and durations; safety	Teizer et al. (2007)
Smart sensors and sensor networks	Temperature, humidity, pressure, strain, rotation; IoT, edge computing	Monitor construction quality; monitor structural heath; monitor safety	Annamdas and Rizzo (2010), Barroca et al. (2013), Kochovski and Stankovski (2018), Salehi and Burgueno (2018)

Table 5: Data acquisition technologies applied to monitoring construction[21]

In addition, the BIM technology is the basic technology that will serve to centralize and visualize the data in the best possible way. This technology will take the form of a DT after incorporating the construction data and the data of real time monitoring of the activity of the building and the possibility to script simulations.

3.5.2 Technological life cycle

What kind of challenge?

- Why is this a challenge?

Every product has different life cycle stages from design to operation. In fact, in the lifecycle study it is mentioned that it is necessary to adopt a global approach that manages the data collected, the information processed, and the knowledge accumulated according to the life

23 Rafael Sacks ; Ioannis Brilakis ; Ergo Pikas ; Haiyan Sally Xie ; Mark Girolami: Construction with digital twin information system: 09/21/20, https://www.repository.cam.ac.uk/bitstream/handle/1810/313570/construction_with_digital_twin_information_systems.pdf?sequence=3

cycle, and that allows a fluid flow between the different domains, through all the phases of the life cycle. This vision leads to the integration of domain specific IoT systems into the entire DT ecosystem. To achieve this vision, the integration of IoT systems must be considered during design, operation, and maintenance, i.e., during the different life cycle phases. These different lifecycle phases are as follows:

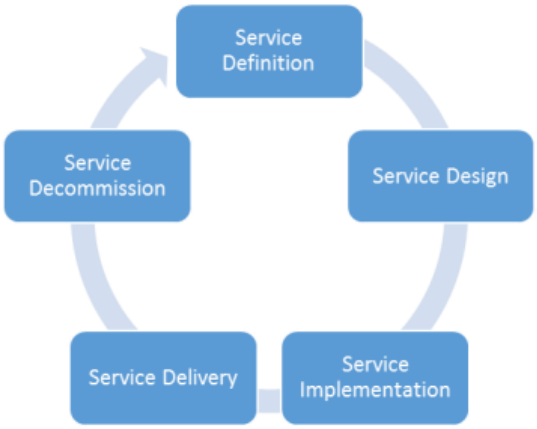


Figure 17:Lifecycle of a technological component.

- What is at stake?

Thus, according to a study of Lifecycle Approach of IoT in the context of Smart Services [24], to better accommodate each phase of this lifecycle, it is paramount to adopt a lifecycle approach to modeling IoT-based smart city service systems to better integrate people, processes, and systems, and to ensure consistency, traceability, and long-term archiving of information.

- What areas/activities/population are affected by this challenge?

The ITU Focus Group on Smart Sustainable Cities categorizes [23:]

- Municipalities, City Council and city administration.
- National and regional governments.
- City services companies.
- Utility providers.

24 Ahmed Hefnawy ; Abdelaziz Bouras ; Chantal Cherifi : IoT for Smart City Services : Lifecycle Approach : 06/01/17, https://hal.archives-ouvertes.fr/hal-01531630/document

- ICT Companies (Telecom Operators, Start-ups, Software, Companies);
- NGOs.
- International, Regional and Multilateral Organizations.
- Industry associations.
- Academia, research organizations and specialized bodies.
- Citizens and citizen organizations.
- Urban Planners.
- Standardization bodies.

- Risk severity: 7 / 10.

Probability 4/10: With a good maintenance of the sensors and a good follow-up, the life cycle of these technologies will be mastered.

Consequences 10/10: The DT being a central element of the PROBONO project, it is important that the technologies allowing the implementation of the DT be adapted to the different LL but also know how to be resilient to the different stages of the life cycle of a technology product that they will undergo. Thus, if this point is not taken into account, the life span of the DT will be considerably reduced.

<u>Which actors will be involved, which actors we will have to contact for the Implementation?</u>

- Actors concerned by the challenge
  - Utility providers.
  - NGOs.
  - International, Regional and Multilateral Organizations.
  - Industry associations.
  - Academia, research organizations and specialized bodies.
  - Citizens and citizen organizations.
  - Urban Planners
- Actors who can bring a solution(s) to the challenges

- ICT Companies (Telecom Operators, Start-ups, Software, Companies).
- Standardization bodies

- Actors with data/information
  - Municipalities, City Council and city administration.
  - National and regional governments.
  - City services companies

What possible solutions can we imagine at this step?

- Existing solution (developed elsewhere)

For each of the stages of the product life cycle described in *Figure 17*, it is necessary to think about the solution to be put in place from the first phase of the project. Still according to the study on life approach, we have [24]:

- For the design phase: the requirements are analysed and the functions of the service system entities, the interfaces, the interoperability between the service system entities, etc. are identified
- For the implementation phase: Information exchange and interactions between service system entities are ensured through service integration, verification and validation (IV&V) and appropriate testing methodologies
- For the service delivery phase: The service is continuously monitored to ensure compliance with predefined key performance indicators (KPIs), to analyse and define potential service improvements and to identify new service concepts in all types of entities.
- For the decommissioning phase: Replacement or elimination of service or service system component.

It is also possible to use the Lifecycle Modelling Language (LML) throughout these phases. LML has the advantage of being a language that works across all phases and stages of the life cycle: Requirements, Design, Acquisition, Verification, Operation and Support, and Disposal.

LML is simpler than other systems engineering languages like SysML in terms of ontology and visual expressions.

- Ideas that can be explored.

There is enough existing solution to manage the technological lifecycle.

3.5.3 Technological change

What kind of challenge?

- Why is this a challenge?

For the past thirty years, the world of work and society has had to adapt to a growth of technological innovations accelerating more and more in order to respond to issues such as better productivity of the company, better management, better communication, etc.

One of the current challenges of the PROBONO project is the use of DTs in order to save a maximum of energy. The objective is to lower the carbon footprint of the studied districts (LL). The world of technology is evolving rapidly, going from innovation to innovation with the emergence of IOT, AI, computers and data centers more and more powerful; new disruptive technologies in their field will probably see the light of day whether in terms of software or hardware.

- What is at stake?

The challenge is therefore to know how to adapt to the various cutting-edge technologies that will be released in the future and thus avoid being disrupted.

But also, to know how to select the most adapted technologies to the projects while decreasing the risks of seeing we useless compared to other technologies that will come out quickly.

- What areas/activities/population are affected by this challenge?

DT designers as well as those responsible for the technical maintenance of sensors and data.

- Risk severity: 3/10.

Probability 5/10: Technology is a domain where progress is important and each technology is surpassed by another one a few years later.

Consequences 1/10: There may be new technologies in the future that are more efficient and powerful, this will not impact the proper functioning of the DT and its interaction with the physical world and the data generated during simulations on the DT will always be reliable and useful as long as the life cycle management of these technologies is effective.

Which actors will be involved, which actors we will have to contact for the Implementation?

- Actors concerned by the challenge

DT designers as well as those responsible for the technical maintenance of sensors and data.

- Actors who can bring a solution(s) to the challenges

DT designers as well as those responsible for the technical maintenance of sensors and data.

- Actors with data/information

DT designers as well as those responsible for the technical maintenance of sensors and data.

For these 3 points, they are the same actors because they are the managers of the data, the sensors and the DT who must ensure the proper functioning of their system and the data provided and must adapt to possible changes in technology.

What possible solutions can we imagine at this step?

- Existing solution (developed elsewhere)

A regular (annual) benchmark to ensure that the technologies used are consistent with those used in the future.

- Ideas that can be explored.

The use of a benchmark is enough.

Summary table

PESTEL ITEM	Category	Risk severity	Actors	Possible Solution
Technologic	▪ Data management	7/10	▪ All the public stakeholder (city, region, country). ▪ The commission ▪ Data providers and managers	▪ Sensors to collect the data. Data platform to collect and manage the data (*Figure **15***)

PESTEL ITEM	Category	Risk severity	Actors	Possible Solution
	▪ Technological life cycle	7/10	▪ All the public stakeholder (city, region, country.) ▪ The commission ▪ Data providers and managers ▪ Urban Planners ▪ ICT Companies (Telecom Operators, Start-ups, Software, Companies) ▪ Standardization bodies	▪ Use the Lifecycle Modelling Language (LML)
	▪ Technological change	3/10	▪ DT designers	▪ Maintain an annual benchmark

Table 6: Summary table technologic PESTLE

3.6 Environmental aspect

Environment part presents the different environmental issues that Brussels LL could face, as well as the strategies and measures to reduce negative impacts on environment and population. In addition, it highlights multiple existing solutions to mitigate Urban Heat Island (UHI) effect and pollution (mainly air pollution), promote recycling and renewable energy, and improve green or climate resilience of the ACE.

3.6.1 Urban heat Island

What kind of challenge?

- Why is this a challenge?

All high density urban spaces can be affected by the Urban Heat Island (UHI) phenomenon. The UHI produces urban areas that experience significant warmer temperatures than their surrounding rural environment, mainly during the night[25]. This phenomenon is caused by the replacement of natural vegetation land by paving materials (e.g., cements, asphalt, etc) for the construction of buildings, roads, and pavements. The thermal properties of those paving materials (e.g., albedo, thermal emittance, thermal conductivity, specific heat, and surface convection) favour the thermal absorption (compared to vegetated natural surface), and lead to a reduction of natural physical and thermal process[26], such as the water infiltration and evapotranspiration of vegetation, which provides shading and mitigate air temperatures[27]. Given the Brussels LL is in the urban area of Auderghem (Region of Brussel's), this could be exposed to this phenomena of microclimate.

- What is at stake?

Different cooling systems, such as air conditioning[28], have gained popularity to keep comfortable thermal perceptions mainly during the summer. However, its use intensifies the UHI effect since these systems absorb heat from interior of building and release heat into the surrounding outdoor environment[29]. In addition, the use of these systems leads to increase energy consumption, air pollution levels and greenhouse gases. High temperatures because of UHI, heatwaves and in general global warming could compromise human health, thermal comfort and rise mortality.

25 Oke, T. R. (1982). The energetic basis of the urban heat island. Quarterly Journal of the Royal Meteorological Society, 108(455), 1–24. https://doi.org/10.1002/qj.49710845502

26 Oke, T. R. (1987). Boundary Layer Climates (2nd ed). Routledge.

27 Castellanos, L. Deploying nature-based solutions in urban areas: thermal performance and urban feasibility across scales. École des Ponts ParisTech, 2022. English. NNT:2022ENPC0013. tel-3764898

28 EPA, 2022. Heat Island Impacts | US EPA.

29 Salamanca, F., Georgescu, M., Mahalov, A., Moustaoui, M., and Wang, M. (2014), Anthropogenic heating of the urban environment due to air conditioning, J. Geophys. Res. Atmos., 119, 5949– 5965, doi:10.1002/2013JD021225

- What areas/activities/population are affected by this challenge?

Events of high temperatures are dangerous for most vulnerable population: elderly people, young children, people with low income, people working outside, people in poor health. In this context, the UHI could result in a threat during the operation of Brussels LL. The impermeable materials of the ACE building and the schoolyard could store and retain the heat, which creates a rising of air temperature on its nearest environment and produce thermal discomfort on children.

- Risk severity: 7.5/10.

Probability 6/10: According to the cooling island map of Brussels from Brussels Environment[30], it can be concluded that Brussels LL is located in an area with medium exposure to elevated temperatures.

Consequences 9/10: The main consequence in the short-term of the UHI phenomenon, the health effects of high temperatures and uncomfortable thermal conditions on most vulnerable populations, such as the children, who attend the Brussels LL.

Which actors will be involved, which actors we will have to contact for the Implementation?

- Actors concerned by the challenge

The effects of climate change on urban areas as well as the modification of the urban microclimate have become a subject of wide interest for several actors. In this direction, the scientific community have been studying and characterizing the physic and thermal features of the UHI phenomenon in most recent years (Téchet et al., 2021[31]; Müler et al., 2014[32] ; Hamdi,

30 https://environnement.brussels/sites/default/files/ilots_de_fraicheur_ensemble.pdf

31 Magalie Técher, Hassan Ait Haddou, Rahim Aguejdad. Characterization of the urban microclimate by the modelling of urban planning policies in France. Journal of Physics: Conference Series, IOP Publishing, 2021, 2042 (1), pp.012065. ff10.1088/1742-6596/2042/1/012065ff. ffhal-03513585

32 Müller N, Kuttler W, Barlag AB (2014) Analysis of the subsurface urban heat island in Oberhausen, Germany. Clim Res 58:247-256. https://doi.org/10.3354/cr01195

2010[33]; Moreno G, 1994[34]). Nevertheless, the complexity of UHI phenomenon and their features are generally not familiar to citizens, but they are aware of their environment physical deterioration and thermal discomfort.

In parallel, the increase of urbanization as well as the frequency and intensity of climate change impacts, have make urban planning policy includes strategies of climate change adaptation. In this way, public authorities promote plans/practices and support financially the sustainable development projects to mitigate the rise of temperature. On the other side, non-governmental organizations have been leading the communication about UHI as well as some different methods of fighting it.

- Actors who can bring a solution(s) to the challenges

Ooststroom, van H (2011) applied a methodology (called process arena), to identify some important regulations and stakeholders involved in the planning context of UHI's at different scales levels in Los Angeles, US: state and local. The main difference between these levels is their influence on UHI's. The local level involves some strategies or interventions that has a more direct impact on UHI's, compared to the state level.

For the ACE Brussels Living Lab, the Local Level could be stressed as the one impacting more UHI's management. According to Ooststroom, van H (2011) methodology, municipality of Brussels and more precisely that of Auderghem, planning agencies, project developers and/or local communities would bring adaptation measures to intervene UHI effects. Those measurements include the use of comprehensive plans, zoning codes or landscape ordinances to directly reduce the urban temperatures by avoiding anthropogenic heat emissions. Some additional measures include incentive programs, awards and certificates, demonstration projects to mitigate the effects of UHI.

33 Hamdi, R. Estimating Urban Heat Island Effects on the Temperature Series of Uccle (Brussels, Belgium) Using Remote Sensing Data and a Land Surface Scheme. Remote Sens. 2010, 2, 2773-2784. https://doi.org/10.3390/rs2122773

34 Moreno-Garcia, M.C. (1994), Intensity and form of the urban heat island in barcelona. Int. J. Climatol., 14: 705-710. https://doi.org/10.1002/joc.3370140609

Besides, urban planners and designs are a key and practical actor to address UHI by integrating sustainable urban infrastructure. NGO are leading outreach and education as well as different methods of fighting UHI's by greening cities.

	Stakeholders	Interventions	Regulations
State Level	State Departments Boards and Commissions Research Groups	Incentive Programs Awards and Certificates Outreach and Education	Air Quality Energy Efficiency
Local Level	Municipality Planning Agencies Project Development Local Communities	Comprehensive Plans Zoning Codes Landscape Ordinances Incentive Programs Awards and Certificates Demonstration Projects Outreach and Education	Construction Environmental Public Safety Procedures Resolutions

Table 7: UHI Process Urban Planning

- Actors with data/information
  - Local meteorological and climate agencies
  - Local government
  - European Environment Agency
  - NGO's
  - The media

<u>What possible solutions can we imagine at this step?</u>

- Existing solution (developed elsewhere)

There are several solutions to mitigate the UHI effect that are reported in the literature. Most of these solutions aim to cooling the urban spaces through the densification of the vegetation and the integration of green infrastructures or Nature-based Solutions, and the creation/improvement of public spaces frequented by vulnerable population.

A brief description of some successful solutions is presented below:

Location	**Strategy**	**Result/Feedback**
Québec, Canada	• Greening of schoolyards	• Significant gains of coolness.

Location	Strategy	Result/Feedback
Reference: https://www.scielosp.org/pdf/rpsp/2016.v40n3/160-166	• Creation green alleys • Installation of white roofs • Creation cool places • Greening of parking lots • Installation of green roofs • Promotion of urban agriculture	• Similar daytime temperatures, whether in rural or urban areas
New York, United States Reference: https://livingarchitecturemonitor.com/articles/lets-put-green-roofs-on-schools-and-help-students-and-teachers-f21#:~:text=Green%20roofs%20are%20the%20modern,ventilation%2C%20and%20air%20conditioning%20systems.	• Public School Green Rooftop program for the installation of green roofs systems on public and secondary school buildings	• Mitigation of UHI by: • Proving shading • Removing heat from the air through evapotranspiration • Reduction of energy consumption: green roof acts as insulator
Aubervilliers, France Reference: https://www.apc-paris.com/actualite/foret-ville-pour-lutter-contre-lilot-chaleur-urbain	• Planting of masses of trees and permeabilization of the urban soil.	• Expected results: Creation of a primary forest at the core of the city that mitigate the air temperature
Paris, France (Oasis project) Reference: https://www.paris.fr/pages/les-cours-oasis-une-reponse-aux-defis-du-changement-climatique-6139/	• Transformation of school yards into cool islands: o replacement of asphalt surfaces permeable and suitable materials for high	• Implication of students and educators on greening schoolyards

Location	Strategy	Result/Feedback
	temperatures, as well as open ground areas. ○ reinforcement of vegetation: trees, green walls and roofs, educational gardens and vegetable gardens. ○ creation of shaded, vegetal or artificial areas. ○ installation of fountains and water games.	
Lille, France Reference: https://www.cerdd.org/Actualites/Changement-climatique/A-Lille-les-cours-d-ecoles-deviennent-des-ilots-de-fraicheur	• Waterproofing and revegetation of schoolyards to create open spaces accessible to children and to sustainably manage rainwater.	• The revegetation of schoolyards brings many benefits: ○ Fighting against UHI by creating cool islands. ○ Improving thermal comfort.

Table 8: Existing solutions regarding UHI.

Figure 18: Existing solutions regarding UHI

Figure 19:Green roof garden in a densely populated area in Montream, Canada, 2012

Figure 20:Oasis project, Co-desing of sustainable schoolyards with students and adults, Paris

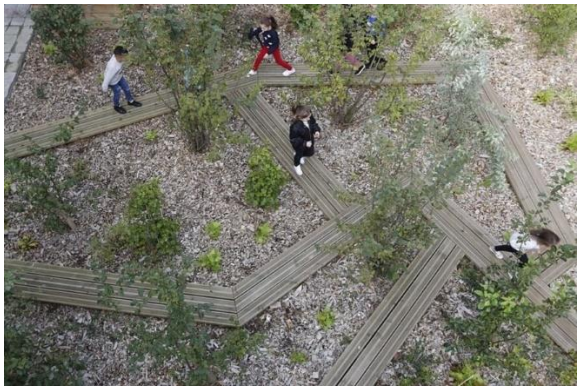


Figure 21:Turgot School, Paris.

- Ideas that can be explored.

To tackle UHI effects the ACE could adopt some successful strategies carried out elsewhere, such as some of those presented previously:

- Greening of schoolyards to turn them into cooling islands.
- Retrofit green roof on existing ACE building.
- Painting pavements or roofs with white coating.

3.6.2 Recycling

What kind of challenge?

- Why is this a challenge?

According to the European Environment Agency, municipal waste account for 27% of total waste generated in the EU, why its management is critical and essential to create sustainable spaces that respect the environment. Apart of reducing the consumption, reuse and recycling are key to tackle waste problem and to improve circular economy. Recycling is the process of collecting materials, and mechanical, physically or chemically processing them into new objects.

Tons of waste are produced in cities and schools. In schools, waste mainly consist of food, paper and packaging.

- What is at stake?

One of main difficulties related to waste recycling is the different forms and materials of wastes, which makes difficult their collection and effectiveness of the recycling process. The wrong separation of wastes lead that these are burning or disposed in landfills, creating additional cost.

Resorting to incinerators and landfills, considered the last resorts in the waste hierarchy, might contaminate the air with toxins and pollutant, the soil or the water by leachates. The leachate is a liquid produced primary by precipitation percolating through waste deposited in the landfill. The contact of waste and water contaminates the water which reach the base of the landfill. Moreover, the decomposition of wastes in landfills creates some gazes, such as the methane, carbon dioxide, water vapor, etc. The methane is one of the most potent greenhouse gases that contributes to climate change.

- What areas/activities/population are affected by this challenge?

Sustainable waste management involves different sites based on the waste life cycle:

- Production: Schools as well as any place where people live or work, produce wastes. It is at this stage that bins and containers for the separation of wastes have to be in operation. Students as well as any person creating a waste have to separate/dispose their waste in the proper container. A proper collection and cleaning of these bins at their surroundings is necessary to avoid sanitary risks because of vector propagations, such as mosquitoes, rats, and other pets.
- Recycling: the recycling centers are facilities used for the storing, keeping, buying, or selling recyclable material. The workers of these centers are exposed to different risks, such as being injured by chemical and biological substances. On the other hand, the neighbours to these centers must bear the noise and atmospheric pollution of the material transformation process.
- Disposal: Apart of the environmental impacts, incinerate or landfill waste also creates human health impact on workers in facilities of waste treatment, because of the production of toxic, gazes and liquids. In addition, the population living close to the landfill site are exposed to landslides and vectors.

- Risk severity: 7/10.

Probability 8/10: The trend of increased waste production in recent years implies that measures must be adopted for the proper management of waste, including recycling.

Consequences 6/10: An inadequate waste management mainly contribute to air pollution and degradation of urban landscape in the Brussels LL. External effects could be generated in the wastes' disposal.

Which actors will be involved, which actors we will have to contact for the Implementation?

- Actors concerned by the challenge

Due to the seriousness of the environmental and health impacts created by the final disposal of waste in incinerators and landfill, it is very important to promote reduction and recycling strategies. It is for this reason that different actors result involved in the solid waste management. Just below, we will describe some of them and their role:

  - Citizens: As responsible of the waste production, are the first actor directly involved in the reuse, recycling, and composting. Hence, they are charged of selection, storing and pre-treatment of wastes. Additionally, citizens have to pay for the recycling and final disposal fee.
  - Local governments: The regulation and operation of waste management systems is the responsibility of local governments. They establish the rules, plans and actions for the reduction, reuse, recycling, collection, and final disposal of waste.
  - Waste Industry: the recyclers are charged of the sorting, dismantling and treatment of the wastes; as well as the manufacturing, distribution and sell of recycled products.

- Actors who can bring a solution(s) to the challenges

Recycling can help the economy by recovering and reusing valuable materials.

At the European Level:

  - The European Environmental Agency bring some indicators for the evaluation of current situation in European countries, as well as some objectives and strategies for respecting European Directives.

At the local level:

- Local councils set the local goal and policies on solid waste management plan, including collection, recycling, and treatment, while municipalities survey its implementation.
- For the specific case of Brussels Living Lab, Brussels Capital-Region controls the solid waste management, including the collection of waste at the source, their transportation, a sorted system for recyclable material and their treatment, incineration in this case.
- Brussels Environment is the environmental agency that promotes several strategies of waste reduction.
- Recycling services: the different enterprises charged of different types recycling wastes: Household, bulky, commercial, construction wastes.
- Schools, including ACE Brussel Living Lab, are a key actor for promoting recycling and sustainable habits, as well as awareness of waste impacts on nature.

- Actors with data/information
  - Local meteorological and climate agencies
  - Local government
  - European Environment Agency
  - NGO's
  - The media

What possible solutions can we imagine at this step?

- Existing solution (developed elsewhere)

According to a study warried out in six schools of Minnesota, US[35], the single-most common material generated by schools was food waste, 23.9% of the total waste generated. Then, recyclable paper accounts the 23.5% of the total waste. According to this characterization, 50%

35 Minnesota Pollution Control Agency (2010). Digging deep through school trash: a waste composition analysis of trash, recycling and organic material discarded at public schools in Minnesota. Available on: https://www.lrl.mn.gov/docs/2010/other/100992.pdf

of school waste could be managed via organics composting programs that accept food waste, liquids, and nonrecyclable paper.

There are some quite feasible solutions leading by Brussels schools includes and Brussels Environment:

- Reducing food waste by setting up quiet lunch/snack times. This favours children's appetite and food waste diminution.
- Zero Waste snacks promoting fruits and legumes, home-made cakes, and using peels for the compost.
- Utilization of food storage bags or reusable boxes, as well as reusable water bottle.

Multiple initiatives have been developed around the world, to minimize and recycling wastes in schools:

- NSW's Sustainable Schools Program
- SCRAP School Communicates Recycling all Paper, Australia
- Recycling Rally, US. Program that benefits K–12 schools by providing valuable incentives and resources to help student make recycling easy, fun and rewarding.
- Some other education programs in schools can be explored here: https://www.eeexchange.org/recycling-programs

Other initiatives aim to promotes waste reuse and recycling:

- Installing school recycling bins for different waste streams.
- Compost bin in schools: Despite the complexity of compost some schools have installed bin for compost. At part of multiple environmental benefits provided by the compost, composting provides a useful way for teachers, pupils and catering staff to explore educational opportunities together. One of advantages of composting is the later provision of a fertilizer that could be used for the schools' grounds.
- Paper recycling

Figure 22:Students at the author's school investigate a compost bin in Chicago

Figure 23:Recycling Rally

- Ideas that can be explored.

Some of the solutions mentioned previously can be explored at the ACE Brussels Lab, such as the installation of bins for recycling, the Zero Waste strategy, the setting up of time to reduce food waste, the reutilization of boxes and bags, the creation of a schoolbook exchange program or the compost of food waste.

3.6.3 Renewable energy

What kind of challenge?

- Why is this a challenge?

Since the industrial revolution worldwide energy consumption has increased and it is expected to increase over the new few decades. Energy is required for electricity, domestic use (e.g., cooking, heating or cooling), and economic sectors (e.g., transporting, agriculture, industry, etc.). Therefore, accessibility to clean and renewable energy is essential in a context of energy transition and digital transformation where technological devices are used globally for people's daily lives.

Nowadays, oil is the main primary energy fuel in the world, followed by other fossil fuels such as coal and natural gas. The consumption of these non-renewable sources implies their depletion, as well as the contribution to the climate change because of the emission of greenhouse gases during their combustion.

In recent years, energy derived from renewable resources, for example sunlight, wind, water, or biomass, have become more frequently used as worldwide investment in clean and green energy, and climate change mitigation, has increased. These sources of energy are inexhaustive,

have stable prices and multiple environmental benefits, as well as they create jobs and economic benefits.

The extraction of fossil fuels (e.g., oil, gas and coal) impacts on different ways the areas of extraction and their population:

- Direct impact of extraction activity: increasing noise and air pollution, land degradation, destruction of ecosystems, production of toxic waste, alteration of water quality, and disorientation of fauna.
- Indirect impacts of infrastructure development and expanded human activity: ecosystem destruction and fragmentation, deforestation for construction of roads, facilitation of invasive species and pathogen movement.

Consequences of extraction disaster: widespread damage and pollution of ecosystems, as well as flora and fauna, contamination of groundwater, land subsidence.

The country and local areas where fossil fuels are burned for electricity generation, are source of greenhouse gases emissions, such as carbon dioxide. In addition, population living near to these areas are exposed to additional air pollutants, such as sulphur dioxide and nitrogen oxides, both contributors to acid rain, toxic metal (arsenic, lead, cadmium and mercury) and soot (particular matter).

In a perspective of sustainable energy growth and reduction of greenhouse gas emissions, it is necessary to adapt renewable energy production strategies that are efficient, affordable, and reliable.

- What is at stake?

According to the Eurostat, the main energy sources in the European Union are the fossil fuels, such as the oil, petroleum products, and the natural gas (see Figure below). During the combusting process of these type of energy sources, greenhouse gases like dioxide carbon or methane are released to the atmosphere, which result in a brake for the strategies and plans of mitigation and adaptation to climate change.

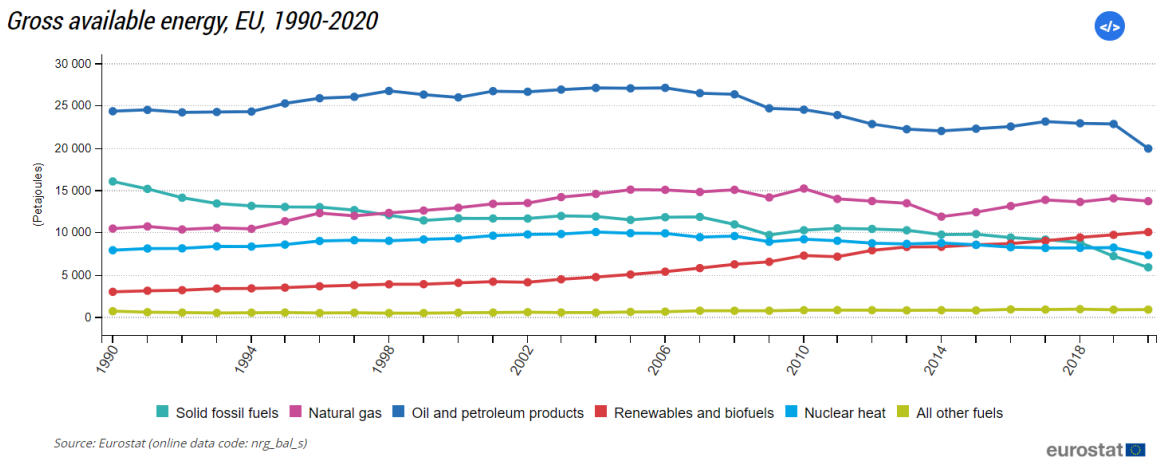


Figure 24: Available energy in the European Union from 1990 to 2020

The use of renewable energy is key for a low-carbon economic development, while protecting the environment, mitigating climate change, improving quality of life, and reducing reliance on external suppliers of oil and gas. The production of renewable energy favours the mitigation of greenhouse gases and the fulfilment of the main objective of the Paris Agreement.

In this way, the Renewable Energy Directive (2018/2002/EU) established a renewable energy target for the European Union of at least 32% as well as an overall energy mix of at least 40% by 2030. In parallel, the United Nations through the Sustainable Development Goal (SDG) 7, claim for ensuing access to affordable and clean energy. According to the Energy Progress Report of SDG 7, 100% of Belgium population has access to electricity and clean cooking, but only 10% of total final energy consumption comes from renewable energy[36].

The increase of renewable energy production reduce dependence on foreign energy sources while provides environmental benefits.

- What areas/activities/population are affected by this challenge?

The production of energy from renewable sources has some technical, environmental, and social challenges. Generally, renewable energy plants require large areas which can interfere with the existing land uses and lead to multiple environmental and wildlife habitat impacts.

A part of this, social acceptance is at the core of the implementation and functioning of renewable energy technologies. Even if a renewable energy project is economically and

36 https://trackingsdg7.esmap.org/

technically feasible, social resistance of local communities nearby production areas could delay and interrupt renewable projects.

- Risk severity: 7.5/10.

Probability 8/10: Because of the European directives and national plans that stipulate the objectives for the reduction of fossil sources use and the transition to low-carbon energy sources, different renewable energies projects should be deployed.

Consequences 7/10: Such projects would generate several positive benefits for climate, health, economy, and energy independence. However, its implementation could generate negative effects on ecosystems and biodiversity, and its rejection by local communities.

Which actors will be involved, which actors we will have to contact for the implementation?

- Actors concerned by the challenge

Governments around the world have integrated policies to mitigate climate change, these include the production, distribution and consumption of energy. In consequence, local actors can stimulate behavioural changes, engender local acceptability, develop renewable energy infrastructure.

Some renewable energy projects in Japan and Germany have demonstrated that local population also can be actively involved in promoting (through education/dissemination) and implement pilot sustainable energy projects [37].

- Actors who can bring a solution(s) to the challenges

The lasted regulatory requirements of the Green Deal should be addressed during the renovation of Brussels Living Lab. These include the main energy and climate policy document, the National Energy and Climate Plan (NECP) which set 17.5% by 2030 of renewable energies and the regional targets of Brussels Capital Region.

At the regional level of Brussels-Capital Region, regional government is charged for the reduction of buildings emissions and their energy demand, and for increasing renewable heating and cooling. To achieve this, multiple measures are implemented, such as direct financial support,

37.https://www.researchgate.net/publication/340771812_Analyzing_Actors'_Engagement_in_Sustainable_Energy_Planning_at_the_Local_Level_in_Ghana_An_Empirical_Study

loans and tax deductions for renovations, building codes, energy performance certificates, and information platforms for consumers.

In order to reduce energy consumption and increase the energy mix in Brussels Living Lab, some initiatives and mechanisms promoted and supported by Brussels-Capital region can be explored and adopted:

Energy pack: Support program for energy efficacity of buildings and reduction of energy consumption. It includes the free diagnostic of energy losses and high consumption devices, monitoring of energy consumption, design and identification of priority actions to implement, consideration of financial investments, sharing knowledge of good practices, and supporting during the implementation stage.

- Actors with data/information

During the renovation of Brussels Living Labs different devices for the efficient use of energy can be installed in the site by the ACE. Among them, lighting sensors, thermostats for heating and air conditioning, as well as timers for a fully characterization of energy consumption which facilitates the decision-making process and serves for energy users education campaigns.

What possible solutions can we imagine at this step?

- Existing solution (developed elsewhere)

Renewable Energy Communities (REC): This strategy aims to create a single legal and local entity for renewable energy production, while provides environmental benefits as well as improves economic and social conditions of members, local communities, or shareholders. This initiative will be tested in Porto Living Lab and it has been successfully implemented in nine EU countries in the framework of the H2020 COME RES research project to facilitate the diffusion of renewable energy communities.

Rooftop solar power: The installation of different photovoltaic (PV) systems is a way to be ensure an independent energy supply in schools. Several schools around the world have solar installations for low-carbon power supply. A case-study in the European Union of rooftop solar power installation and the creation of a solar energy community, is the secondary school of Quatre Cantons in the district of Poblenou, in Barcelona. The solar panels installed on the roof of the school provides power to the school and 30 households in its surrounding area, cutting down their electricity bills by 25%.

Rooftop solar hot water: This system transforms solar light (energy) into heat using the solar panel collector, to warm water for storage in a hot water cylinder or thermal store providing heating. This water is generally used in sinks, showers and kitchens, or for swimming pools.

- Ideas that can be explored.

The initiatives that could be explored in the Brussels Living Lab includes the installation of PV panel for the production of energy as well as the creation of a REC merged with communities of Auderghem Commune for sharing renewable energy.

In addition, the installation of sensors for monitoring energy consumption are necessary adopting the most convenient measures for energy consumption optimization.

3.6.4 Resilience

What kind of challenge?

- Why is this a challenge?

According to the United Nations Office for Disaster Risk Reduction, resilience is the ability of a system, community, or society exposed to hazards to resist, absorb, accommodate to and recover from the effects of a hazard in timely and efficient manner, including through the preservation and restoration of its essential basic structure and functions. Some of the hazard that society has been facing in last decades include the climate change, demographic imbalances, migration pressures and lately the Covid-19 pandemic.

- What is at stake?

The European Commission developed resilience dashboards, to assess countries resilience through a set of indicators that includes its capacity to face shocks and its vulnerability to their negative effects. The indicators span four dimensions according to the 2020 Strategic Foresight Report (SFR): social and economic, green, digital, and geopolitical resilience.

- Socio and economic resilience: This implies “the ability to tackle economic shocks and achieve long-term structural change in a fair and inclusive way”. Here, the inequalities, demographic imbalances and poverty created by pandemics and the consequences of climate change hazards should be considered.
- Green resilience: This is “about reaching climate neutrality by 2050, while mitigating and adapting to climate change, reducing pollution and restoring the

capacity of ecological systems to sustain our ability to live well within planetary boundaries".

- Digital resilience: This makes references" to ensuring that the way we live, work, learn, interact, and think in this digital age preserves and enhances human dignity, freedom, equality, security, democracy, and other European fundamental rights and values."
- Geopolitical resilience: This makes reference to "Europe bolstering its 'open strategic autonomy' and global leadership role".

These four dimensions are at stake, they can have a single impact, or they can be linked to other dimensions, which results in an aggravating factor to reach global resilience.

- What areas/activities/population are affected by this challenge?

Concerning green resilience, the scenarios of development created by the Intergovernmental Panel for Climate Change (IPCC) show increase of temperature, change of precipitation patterns, the frequency and intensity of extreme climate hazards, drought, storms, floods, and rise of sea levels over next decades. Such extreme conditions would force people to abandon their homes and lands, no longer productive.

An example of resilience is showed in 2021 Strategic Foresight Report (SFR) of the EC: the stress water scarcity could become mainly problematic in southern EU countries in next years. This would impact water accessibility for human consumption, but its use for agriculture practices and potentially food security. Hence, socio and economic resilience would be impacted, and population would migrate, as shows in the next Figure:

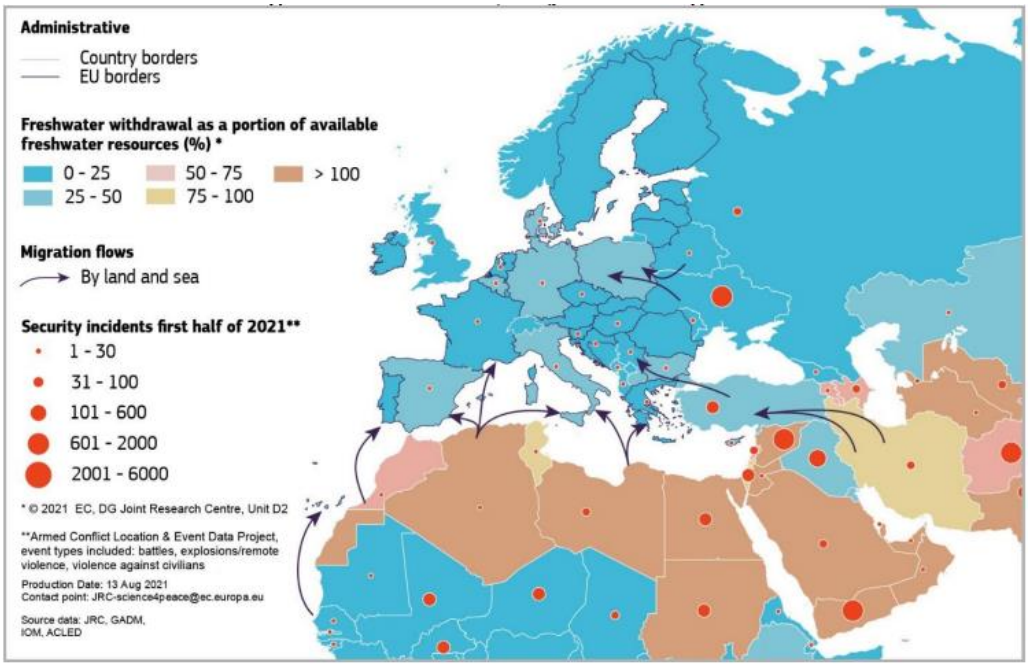


Figure 25:Water stress, conflicts, and migration. Source: 2021 SFR.

In urban areas, acute climate hazards, such as extreme precipitations, heatwaves or wildfires, could impact and cause a physical damage to the infrastructures, as well as the populations.

- Risk severity: 8/10.

Probability 8/10: Highly exposure of climate change effects, pandemics, geopolitical and economic risks of our societies, multiple measures and strategies to increase resilience are in the process of adaptation.

Consequences 8/10: The resilience reinforcement in any of four dimensions (socio-economic, green, digital and geopolitical) bring multiple benefits for the society and multiple opportunities of sustainable development.

Which actors will be involved, which actors we will have to contact for the implementation?

- Actors concerned by the challenge

Some stakeholders that could be concerned to build resilience at the ACE Brussels Living Lab are:

- Educational institutions: These spaces of learning increase community awareness, as well as could encourage children and staff to create innovate ideas and implement practical solutions.

- Communities living near your operations/offices
- Potential consumers
- Business partners/allies
- Suppliers
- NGOs and pressure groups
- Regulators/government
- Competitors
- Investors

- Actors who can bring a solution(s) to the challenges

Local governments have a key role to reach resilience. They not only define plans and strategies of sustainable development, but they also finance risk vulnerability assessments and finally adopt the measures to adapt cities and infrastructure.

Brussels Environment agency promotes the transition into a innovate and low-carbon economy of SMEs through the Resilience COACHING program, a free training season for business advisors. This training aims to identify the profitable opportunities by integrating sustainability and circularity into their activities.

- Actors with data/information
    - Local meteorological and climate agencies
    - Local government
    - European Environment Agency
    - NGO's
    - The media

<u>What possible solutions can we imagine at this step?</u>

- Existing solution (developed elsewhere)
    - TURaS (Transitioning Towards Urban Resilience and Sustainability) was an EU funded project, that aimed the transition towards urban resilience and sustainable. From 2011-2016, this project put together different stakeholders: local authorities,

academic researchers, urban communities and SMEs, to explore and identify the more practical solutions for build resilience and sustainability of European cities, towns and neighbourhoods. Brussels Environment participated in this project with the case-study “Environment-Employment Alliance (EEA), see more details: https://oppla.eu/product/17500 . This project aimed to create an innovative type of multistakeholder alliance to improve employment in Brussels, to revitalise the Brussels economy and to improve the city's environmental record.

- The EC launched the Recovery and Resilience Facility (RRF) to mitigate the economic and social impact of coronavirus pandemic and make European economies and societies more sustainable, resilient and better prepared for the challenges and opportunities of the green and digital transitions. The regulation of RRF requires the implementation of Recovery and Regional Plans (RRP) at national level in line with national legal framework. This will allow to reform as well as increase funding and investments.

The Global Center on adaptation published a report of 15 innovative measures[38] implemented by educational institutes in Africa, and across the globe, for the adaptation and climate resilience in schools. Some of these initiatives includes:

- Water harvesting for water security – Kenya: Installation of water tanks and sanitation infrastructure on building rooftops to harvest water during rainy season and minimize local flooding and create water storage for drier months.
- Resilience through locally grown food – Madagascar: To increase resilience and reduce vulnerability to Climate Change, the Antafotenia Primary School conducted a vegetable farming competition among different grade levels.
- Reconnecting with nature through climate-responsible consumption and food production –Mauritius: Loreto College implemented a wide Zero Waste Campaign to engage student in refusing the use unsustainable products reducing wastage, reusing materials, enhancing recycling, and composting. In addition, student participate in nature education activity in nearby farms about scientific knowledge,

38 https://gca.org/reports/case-studies-on-adaptation-and-climate-resilience-in-schools-and-educational-settings/

community interactions, ecosystem awareness and skill enhancement. Moreover, students are involved in the construction and maintenance of an aquaponic system, which combine aquaculture (raising fish) and hydroponic (soil-less growing plants), as a pilot model of sustainable food production.

- Beekeeping to foster resilience – Tanzania: assessment of unsustainable practices for Kanga Forest reserve in Tanzania, and installation of beehives adjacent to the forest, managed by students, teachers and community members.
- Education for locally-led adaptation – Tanzania: set-up of an apiculture in the surrounded area of the Digalama Primary School. The economic benefits from honey selling are reinvested in a fishing pond and banana farming.
- Reconnecting with nature through rainwater harvesting - The Republic of Seychelles: The Schools Rainwater Harvesting Project aims to harvest rainwater at the roof of the schools for its use and educate the student and local communities in climate change impacts and how rainwater can be utilized as a mean of adopting to water scarcity.
- Building a climate resilient school ground (Klimaatspeelplaats) – Belgium: The Sint-Paulus Primary School is in the Flanders region of Belgium initiated the “dream playground” project, to convert schools’ playgrounds with concrete into green and nature friendly areas. The project includes a participatory process of the pupils and teachers for the design of the playground with nature. Then, concrete was removed to allow rainwater infiltration and collection in a basin, and recycling park for waste, vegetable garden and greenhouse were installed. The playground was transformed in a climate-friendly campus.
- Creating climate resilient communities – US: Different activities have been developed along US to increase climate and resilience awareness.

  → Since 2017, the National Wildlife Federation in New York City has been delivering the Resilient Schools Consortium (RiSC) to train secondary school students about climate science, current and future climate impacts, and resilience strategies.

- The Resilient Schools Consortium (2019-2020) engaged students in learning about and taking action to mitigate coastal flooding and extreme heat in their

communities. It also helped them to understand the critical links between climate justice and climate resilience.

- "Adopt-a-Shoreline" guide was developed in 2021 to teach students about coastal ecology, biodiversity, and the role of nature-based resilience features, such as marshes and dunes, in local communities.

- Ideas that can be explored.

Initially, a climate risk and vulnerability assessment of the ACE's building could be performed. This assessment will allow to determinate: i) the exposition of the ACE building to chronic and acute climate hazards; ii) the sensibility and the vulnerability of the building and its different components to negative effects of the climate hazards; and iii) the necessary measures to mitigate the sensibility and the vulnerability of ACE to physical damage.

In addition, ACE Brussels Living Lab could explore some initiates mentioned previously for building resilience, such as education campaigns, installation of tanks for water harvesting for cleaning and watering purposes.

3.6.5 Pollution

What kind of challenge?

- Why is this a challenge?

The United Nations defines pollution as the presence of any substances and heat in environmental media (air, water, land) whose nature, location, or quality produces undesirable environmental effects. In this way, there are three major types of pollution:

- Air pollution
- Water pollution
- Land/Soil pollution

Following World Health Organization definitions, air pollution is contamination of the indoor or outdoor environment by any chemical, physical or biological agent that modifies the natural characteristics of the atmosphere. Water pollution is the release of substances into bodies of water that makes water unsafe for human use and disrupts aquatic ecosystems. And land

contamination refers to the deterioration of land surface because of the introduction of foreign substances.

The pollutants affecting air, water and land quality can have two different sources: The point source, that comes from an easily identifiable and confined place, and the nonpoint source is a diffusion pollution that does not originate from a single discrete source.

	Type of pollution		
Pollutant	*Air*	*Water*	*Land*
Point Source	• Factories • Oil refineries • Electric power plants • Sewage treatment plant	• Industrial facilities • Wastewater treatment plants • Overflows from storm water sewers	• Mining, erosion, and quarrying • Construction • Deforestation • Poor agricultural practices • Accidental contamination • Landfills
Nonpoint source	• Smoke emissions from vehicles • Garbage burning • Use of aerosols and insecticides	• Agricultural and residential runoff • Urban runoff • Construction sites and land disturbances	

Table 9: Different types of pollution

There are two additional types of pollution with high impact on human, noise and light pollution. Noise pollution is the unwanted or disturbing sound in the environment, and light pollution is the excessive or inappropriate use of outdoor artificial light. Both type of pollution affects the health and well-being of humans, but these pollutions could also disrupt animal communication and wildlife behaviour.

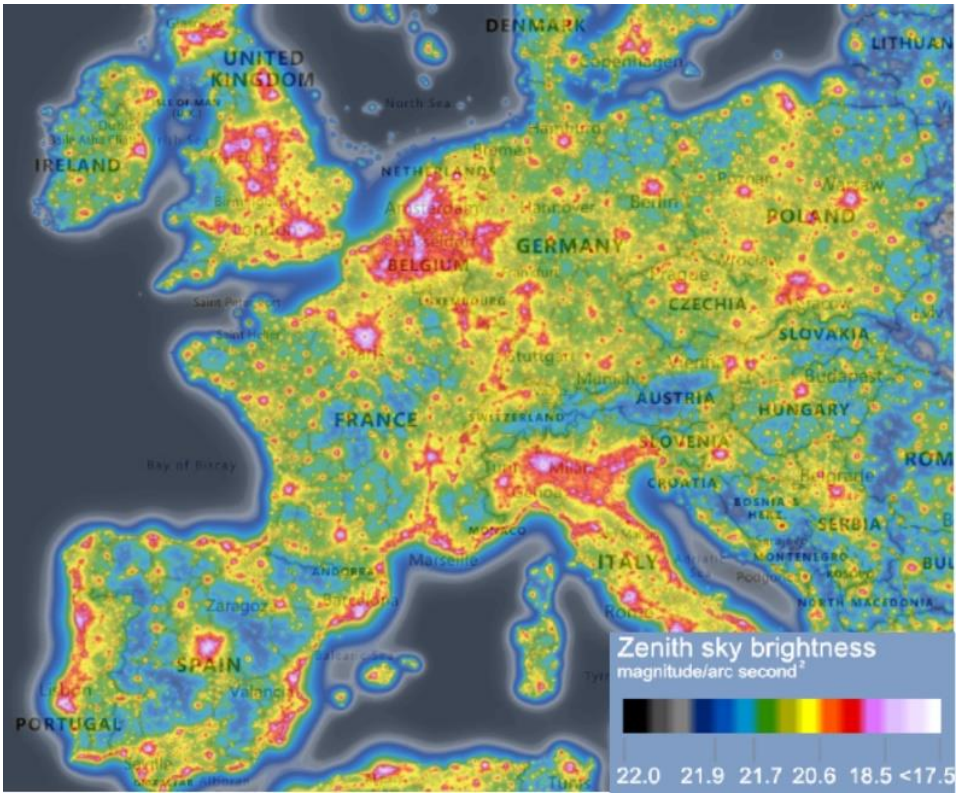


Figure 26:World Atlas 2015 of Artificial Night Sky Brightness [39]

- What is at stake?

According to the European Environmental Agency, air pollution is the biggest environmental health risk in Europe. The population exposure to atmospheric pollutants, such as Particulate matter (PM10) and fine particulate matter (PM2.5), Ozone (O_3), Nitrogen Dioxide (NO_2) and sulfur dioxide (SO_2), is associated with several health problems as respiratory infections, heart disease, stroke, lung cancer, etc.

- What areas/activities/population are affected by this challenge?

39 https://www.lightpollutionmap.info/

The Figure below shows the European Air Quality Index, which is based on concentration values of five pollutants: PM10, PM2.5, O_3, NO_2, SO_2. This index provides information about the potential impact of highest pollutant on human health.

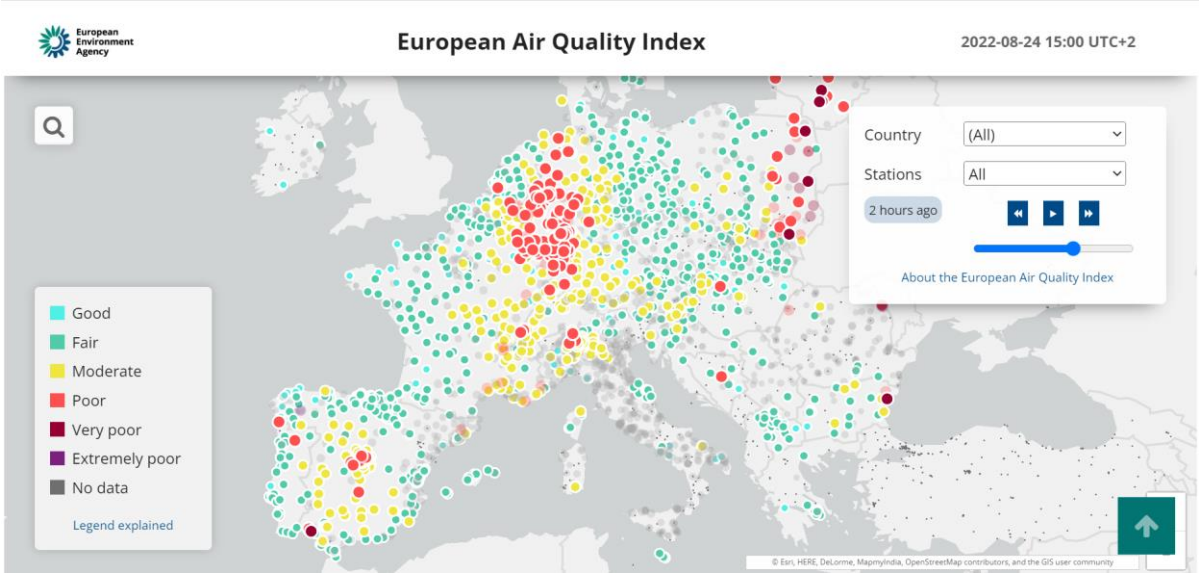


Figure 27: Air Quality Index on August 24th of 2022 [40]

In this specific case, population in areas with poor AQ index could experience symptoms such as sore eyes, a cough or sore throat; then the reduction of intense activities outdoors is recommended, especially for sensitive populations (e.g., older adults, children, people with heart and lung disease, including asthma, pregnant women).

Noise pollution is one of major environmental health concern in Europe. High and prolonged exposure to noise has negative impacts on human health, such as stress related illnesses, high blood pressure, speech interference, hearing loss, sleep disruption, and lost productivity. According to the EEA "long-term exposure to environmental noise is estimated to cause 12.000 premature deaths and to contribute to 48.000 new cases of ischemic heart disease per year in the European territory. It is estimated that 22 million people suffer chronic high annoyance, and 6.5 million people suffer chronic high sleep disturbance. As a result of aircraft noise, 12500 schoolchildren are estimated to suffer learning impairment in school."

The NOISE Observation & Information Services for Europe (from the EEA) has mapped the environmental noise levels from roads, railways, airports and industry. In its site, NOISE stress

40 https://airindex.eea.europa.eu/Map/AQI/Viewer/

road traffic as the main source of noise in Europe, affecting one in four people, as most times "annoyance" and "sleep disturbance" thresholds, 55dB and 50dB respectively, are exceeded. Below, the Figure shows the number of people exposed inside urban areas in Belgium to high levels of noise above the EU thresholds for different noise sources.

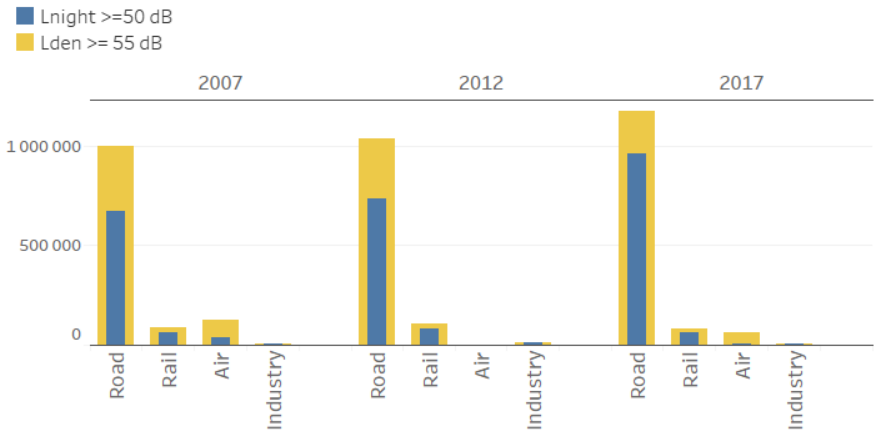


Figure 28:. Number of people exposed to high noise levels – Belgium [41]

- Risk severity: 9/10.

Probability 10/10: Due to the increasingly high frequency of air pollution episodes that exceed the recommendations of the World Health Organization, as well as the high exposure to high noise, the probability of pollution is maximum.

Consequences 8/10: Chronic or acute air and noise pollution can generate several negative effects on people's health as well as on biodiversity.

<u>Which actors will be involved, which actors we will have to contact for the implementation?</u>

- Actors concerned by the challenge

Stakeholders involved in local air quality management process according to Beattie, C et al. 2020 study are:

41 https://www.eea.europa.eu/themes/human/noise/noise-fact-sheets/noise-country-fact-sheets-2021/belgium

- Environment Agency: determine air quality information dissemination, monitor air pollutants and noise pollution, model air quality, and is charged of communicate air pollution effects.
- Cities and local authorities: crucial for setting up the targets of pollution reduction, as well as implement and manage plans, strategies, and necessary measures to reach those targets.
- Health authorities: they are charged of carry out studies of air pollution and health relationship, and health impact assessment.

- Actors who can bring a solution(s) to the challenges

The government of Brussels-Capital Region and its environmental agency, Brussels environment, have establish different programs and plans to promote and execute the policy environmental impacts and air pollution reduction:

Code for Air, Climate and Energy Management (COBRACE in French) was adopted since 2013 and set up different goals: Regional targets of greenhouse gases reduction, carbon neutrality by 2050. This policy created the climate experts committee for the evaluation of regional policies, targets, and measures.

- Brussels Air Climate Energy Plan (PACE) adopted in 2016. This plan proposes 64 measures and 144 actions for the 30% reduction of greenhouse gas emissions by 2050; as well as characterizes the source of atmospheric pollutants and promotes renewable energy production.
- The heatwave and ozone peaks plan anticipate climate conditions that favours heatwaves and ozone peaks and sept up actions which prevent and limit risks for population, in particular children, elderly and/or isolated people.
- Cairgo Bike is a plan implemented from 2021 that aims to test cargo or long tail bikes for two weeks in Brussels municipalities, with the support of ProVelo to get started with confidence. Besides, users are encouraged to measure air quality using sensors provided by Brussels Environment. This will study the exposition of participants to air pollution and will compare with other means of transport.
- The Brussels-Capital Region is a Low Emission Zone (LEZ) from 2018. The measure prohibits vehicles (mostly old diesel vehicles) that emit more pollution, to drive in

19 communes of Brussels, including Auderghem where is located ACE Brussels Living Lab.

- The Low Emission Mobility (LEM) strategy of Brussels-Capital Region towards low-carbon mobility established some goals: Increasing the efficiency of the transport system; speeding up the deployment of low-emission alternative energy for transport; and moving towards zero-emission vehicles.

- Actors with data/information

The noise pollution maps from the EEA offer valuable information at local and European scale noise levels, which could support the evaluation of initiatives efficacity developed at local and national scale, and the comparison and analyse of air quality levels in cities with similar context and their successful initiatives.

At local level, the telemetry network of Brussels-Capital Region and Brussels Environment, will indicates the levels of air pollutants. More specifically, the Cellule Interrégionale de l'Environnement (CELINE in French) reports the measurement values of O_3, NO_2, PM10 and PM2.5 every hour. Moreover, a forecast model of these pollutants is developed by CELINE to predict air quality.

In the same way, the environmental agency, Brussels Environment for the ACE case, provides the noise maps in Brussels from road, rail, air and industry sources.

<u>What possible solutions can we imagine at this step?</u>

- Existing solution (developed elsewhere)

Schools are a very strategy place to address air pollution as most of their community comprises children, a vulnerable population group to this kind of pollution.

- Clear Air for School is a framework designed to create an air action plan to tackle air pollution in and around the schools in UK. Under the essential actions that are promoted, we find:

  → Reduce the volume of traffic outside the school by, for example, implementing a school street.

  → Improve air quality inside the school by, for example, improving ventilation.

→ Create low pollution habits with the future generation by engaging students and their families with advice on tackling air pollution.

→ Use the children's and school's voice to encourage local and national decision makers to make air quality improvements across your local area.

CleanAir@School was an initiative of the EPA and the EEA, to monitor air quality around schools across Europe and to understand children's exposure to the NO_2. This initiative involved citizens for measure the NO_2 in the schools, using low-cost devices, while children and citizens learnt about air pollution and its health effects. The types of instruments used for measuring air quality:

→ A passive air polluant sampler (or 'diffusion tube')

→ A low-cost air pollution sensor

→ An air pollution sensor system

→ An air pollution reference instrument

→ In the northern region of Belgium, the University of Antwerp and the Flanders Environment Agency, implemented one of largest citizen science project on air quality called Curieuze Neuzen Vlaanderen (Curious Noses Flanders). Citizens were equipped with a passive sampler to measure NO_2 concentrations in Flanders. This allowed to develop maps of NO_2 concentrations as well as to improve the air quality model.

→ Promotion of walking or cycling to school, to improve people's health.

→ Protecting Playgrounds: Nature-Based Solutions (NbS) were installed in five schools across Manchester-UK, to improve air quality and reduce the damaging health effect to school children.

→ Installation of green walls to improve air quality in the playground and pavement outside the school for students walking to schools.

Figure 29:Green wall in Melcombe Primary School- UK [42]

- Ideas that can be explored.
  - The installation of NbS seems to be promising measure to reduce noise and enhance air quality in school playgrounds, improve biodiversity and human well-being, as a green barrier is created. However, it is important to consider the disservices of NbS, for example in some cases trees worsen pedestrian-level pollution as they reduce airflow and dispersion of vehicle pollutants; as well as the pollen emissions and biogenic volatile organic compounds (BVOCs).
  - Restricting smoking around the entire school area.
  - Inspecting building material for harmful substances if construction is taking place.
  - Installing proper and efficient ventilation systems throughout the school so that the air remains pure and clean.
  - Installation of low-cost sensors for air pollutants monitoring

[42] https://www.biotecture.uk.com/portfolio/melcombe-school-greening/

Summary table

PESTEL ITEM	Category	Risk severity	Actors	Possible Solution
Environmental	▪ Urban heat island	7.5/10	▪ Local meteorological and climate agencies ▪ Local government ▪ European Environment Agency ▪ NGO's ▪ The media ▪ Brussels LL	▪ Greening of schoolyards to turn them into cooling islands. Retrofit green roof on existing ACE building. Painting pavements or roofs with white coating.
	▪ Recycling	7/10	▪ European Environmental Agency ▪ Local actors: local council, Brussels Capital-Region, Brussels Environment, recycling services companies.	▪ Installation of bins for recycling and creation of compost from food waste.
	▪ Renewable energy	7.5/10	▪ Local actors: local council, Brussels Capital-Region,	▪ Installation of sensors for monitoring

PESTEL ITEM	Category	Risk severity	Actors	Possible Solution
			regional government.	energy consumption, PV panels in the roofs of the ACE, and creation of a REC merged with communities of Auderghem Commune.
	▪ Resilience	8/10	▪ Local meteorological and climate agencies ▪ Local government ▪ European Environment Agency ▪ NGO's ▪ The media	Assessment of climate risk and vulnerability assessment of the ACE's building. Education campaigns, installation of tanks for water harvesting for cleaning and watering purposes. ▪
	▪ Pollution	9/10	▪ Local actors: Brussels-Capital Region and Brussels	▪ Installation of NbS, ventilation systems and

PESTEL ITEM	Category	Risk severity	Actors	Possible Solution
			Environnement, Cellule Interrégionale de l'Environnement	air pollution monitoring sensors.

Table 10 : Summary table environment PESTLE

3.7 Legal aspect

3.7.1 Data protection

What kind of challenge?

- Why is this a challenge?

This renovation project will integrate technological devices that will register data about its users. The challenge on data protection in this case lies on ensuring that the data collected in not used for other purposes than allowing the running of the project.

- What is at stake?

When it comes to data collection, the privacy and therefore safety of the users of the building is at stake.

- What areas/activities/population are affected by this challenge?

The population affected by this challenge are firstly the school users (pupils, teachers, technicians) but also the school administration as they are in charge of the data protection of the Living Lab.

- Risk severity: 2.5/10

Probability 4/10: The probability of the data not being protected is on the rise as time goes because of the various threats than are now possible. However, the school must have had a data protection system in check with the expected regulation. Therefore, the probability of data not being protected might be moderate

Consequences 1/10: However, if it happens that the school data are jeopardised that could influence the safety around the school and its users, but it will not directly impact the renovation project.

Which actors will be involved, which actors we will have to contact for the Implementation?

- Actors concerned by the challenge

The actors concerned by this challenge are the school administration and the school users. Both parties will produce data during their time in the Living Lab and are therefore concerned by the challenge regarding data protection.

- Actors who can bring a solution(s) to the challenges

The actors that can bring a solution are the school administration as the authority of this Living Lab. But also the maintenance team as they will be the one handling the innovative elements.

- Actors with data/information

The actors with the information about the data protection law are also the school administration as they are to protect the data of their pupils. It is also possible that they spread this knowledge about data protection to the teachers and to the pupils too.

What possible solutions can we imagine at this step?

- Existing solution (developed elsewhere)

There already exists numerous solutions regarding data protection. This challenge being nowadays a global, the multiple ways to protect ourselves are commonly shared. Among the most spread solutions, we have:

- Following a strict policy about passwords (changing it regularly, never use the same on different websites, use a complex and random series of letters and numbers)
- Using a VPN while on a being connected to a public WiFi
- Be careful while downloading new apps (some apps might require access to information that are in no way connect to their original purpose, in that case the best solution is not to download such an app)
- Keeping the software updated
- Be careful about what we are sharing on social media

- Ideas that can be explored.

n/a

3.7.2 Construction law

What kind of challenge?

- Why is this a challenge?

The challenge is for the project to respect the construction law from the general framework, to the licenses and permits, health and safety during the renovation works but also once the project is done, and finally environmental assessment and sustainability of the whole project.

- What is at stake?

Through this aspect, the validity of the project is at stake. If the project does not meet any mandatory requirement expected by the Belgian construction law, it can negatively impact the project by possibly putting it in standby. In that case, the public image of the project will be impacted but internally a standby could lead to important money lost.

- What areas/activities/population are affected by this challenge?

This challenge will directly affect the project and every actor in it. From the construction workers that will have to stop their activities to the management team that will have update the timeline and budget, any trouble with construction law could have a non-negligible impact on the project.

- Risk severity: 5/10

Probability 1/10: The probability of the construction law not being respected is quite low as the project has already been validated.

Consequences 9/10: The consequences of construction law not being respected might create a delay for the mistakes to be rectifies, maybe a fine will be applied so this might also affect the budget and in worst case scenario this can block the project.

Which actors will be involved, which actors we will have to contact for the Implementation?

- Actors concerned by the challenge

The actors concerned by this challenge are the school administration, project designers and the public administration.

- Actors who can bring a solution(s) to the challenges

The actors that can bring a solution in this situation are the legal team of the project.

- Actors with data/information

Similarly, the people with data and key information in case of a legal matter are the legal team.

What possible solutions can we imagine at this step?

- Existing solution (developed elsewhere)

A solution to this challenge might be to involve construction's law experts but also to establish a double or triple check process when it comes to the requirements of the law in this sector.

Summary table

PESTEL ITEM	Category	Risk severity	Actors	Possible Solution
Legal	▪ Data protection	2.5/10	▪ School administration ▪ School users ▪ Maintenance Team	▪ Data safety measures
	▪ Construction law	5/10	▪ School administration ▪ Project designers ▪ Public administration ▪ Project Legal Team	▪ Deep checking of the law requirements.

Table 11 : Summary table legal PESTLE

3.8 Conclusion of the Brussels LL PESTLE Analysis

In this study, risk severities were given according to the probability of the scenario occurring and the severity of the scenario occurring. This score will be developed and detailed in the next deliverables of task 1.4. Here is a summary of the scores. Thus, the average is as follows:

	POLITIC	ECONOMIC	SOCIAL	TECHNOLOGIC	LEGAL	ENVIRONNEMENTAL
RISK SEVERITY AVERAGE	3 / 10	6,25 / 10	2,375 / 10	5,7 / 10	3.75/10	7,4/10

Table 12 : Risk severity average for Brussels LL

The legal and environmental aspects therefore represent the categories with the highest risk.

In order to adapt to these risks, possible solutions have been evoked in this analysis and will be explored concretely in their application to the LL of Brussels in the continuation of the project.

4 Difference between Brussels LL and others

This part traces the differences between the other LL and the one in Brussels. Each LL representative filled in this table because their knowledge of the local context allows them to define at least these main differences. Thus, these differences will be studied during the next deliverables of the task 1.4 in order to obtain, from the work done for the Brussels LL, a PESTLE analysis adapted to each LL.

4.1 Madrid

Pestel Item	Elements that are different with your LL	Why is it different?
Politics	1. Budget 2. Paris Agreement 3. Citizen Involvement	1. Madrid LLab is involved in Madrid New North (MNN) , that is an urban redevelopment programme in the Spanish capital city of Madrid, managed and promoted by privately-owned company Distrito Castellana Norte. 2. MNN follows the General Urban Development Plan of Madrid and the regulations of Specific Planning Areas (APE 08.21 Las Tablas Oeste). Total primary energy consumption < 85% limit value established in the CTE (technical building code). Non-renewable primary energy consumption < 70% limit value established in the CTE (technical building code).

		3. GBN Citizen Awareness Activities: DCN will use their already established citizen awareness centers to integrate the citizens in the development of the system. Business model for citizen integration (Renewable Energy Community)
Economic	1. Green finance options 2. GDP/ per habitant	1. Geothermal District Network (Probono budget) Development of urbanization project (*not included in the Probono budget, managed and promoted by privately-owned company Distrito Castellana Norte DCN 2. Buildings (*not included in the Probono budget, managed and promoted by privately-owned company Distrito Castellana Norte DCN. Thermoactivation of the buildings connected to DN (probono budget) 3. GDP/ per habitant: Madrid 32.048 euros
Social	1. User acceptance 2. Education	1. Focused on minimizing the geothermal network impact on the neighborhood through naturalization process of the geothermal plant, and reducing their dimensions and use of renewable energy to feed the heating and hydraulic pumps of the geothermal network.

		2. Co-creation and design/engagement actions with end-users of the buildings. Innovation clusters used by LL: Madrid Subterra, ADHAC, EE Platform
Technologic	1. Data Management/Digital twin	1. Refer to D5.1 for list of Digital Twin use cases and high-level objectives for the Madrid LLab
Legal	1. Construction law	1. MNN follows the General Urban Development Plan of Madrid and the regulations established in Specific Planning Areas (APE). In Spain there is no specific regulation for geothermal network deployment, so it is expected that Madrid LLab aims to create a technical, legal, and financial framework for large scale geothermal network district system.
Environment	1. Urban Heat Island	1. Madrid Nuevo Norte, the first urban project in Europe to obtain LEED and BREEAM pre-certifications MNN has been registered to achieve LEED Cities and Communities and BREEAM ES sustainable certifications aiming the highest qualification in both rating systems. The use of Level(s), besides DGNB as part of the certification/standardization analysis and benchmarking.

Table 13 : Madrid LL Pestle Analysis

4.2 Dublin

Pestel Item	Elements that are different with your LL	Why is it different?
Politics	1. Budget: Actors concerned with the challenge 2. Paris Agreement 3. Citizen involvement	1. DLR County Council is the main actor concerned with the Dublin LL challenge, as all buildings in the GBN are municipal buildings, occupied by DLR staff and/or the public. 2. Relevant Irish legislation: Climate Action and Low Carbon Development Bill 2021 3. Citizens engaged will differ from Brussels as they will include general citizens of DLR, library users, County Hall users, Social Housing tenants, and DLR staff.
Economic	1. Finance options 2. GDP/ capital	1. Should the Probono project fall short in funding for Dublin LL interventions, the project will collaborate with concurrent EU projects such as Deliveree which are developing renewable energy among DLR buildings. 2. GDP/ capita Ireland: €83K
Social	1. User acceptance 2. Education	1. User groups for Dublin LL as per 4 & 6 above. 2. Education in Dublin applies to i) DLR employees' familiarity with building energy systems and ii) public education

		relating to the project and low energy buildings in general. 3. Actors related to the task include the design team, facilities management, and DLR community outreach staff.
Technologic	1. Data Management/ Digital Twin	1. Refer to D1.5 for list of Digital Twin use cases and high-level objectives for the Dublin LL.
Legal	1. Data protection 2. Construction law	1. All the data produced by the Dublin LL will be treated per GDPR requirements. The most sensitive data will relate to social housing tenants. Information gathered by the Climite devices installed in several DLR social housing units, for example, is identifiable by house number. 2. Construction law is governed in Ireland by the Building Regulations; all works will comply with the Building Regulations Technical Guidance Documents (TGDs).
Environment	1. Urban heat island	1. Given the GBN's maritime location in a low-density area with surrounding green space, along with the prevailing Irish climate, it is not expected that the urban heat island effect will be a major consideration for the Dublin LL.

Table 14: Dublin LL PESTLE Analysis

4.3 Porto

Pestel Item	Elements that are different with your LL	Why is it different?
Politics	1. Budget 2. Paris Agreement 3. Citizen Involvement	1. As a private company, Sonae has other means to acquire financing than funded projects. 2. Sonae, the owner of the campus, signed the Paris Agreement in 2015 but in 2020 committed to reach carbon neutrality in 2040 on all of its operations, so even more ambitious targets 3. The GBN area of Porto LL is an industrial/office campus the major impact will reach the ~ 3000 workers that every day go to the campus.
Economic	1. Green Finance 2. GDP per habitant	1. Following the information on (1) it is also clear that it is part of Sonae's vision to become "greener" and more sustainable, on the next years/decades so it will give a boost to all the projects that contribute for this target 2. GDP/habitant in Portugal = 19k€
Social	1. User Acceptance 2. Lifestyle 3. Education	1. The users are different (not a living area, but a work area) and also there are companies involved. 2. It will affect the workplace of the users and not their living area so the impact will be different

		3. The social dimension of the LLab will make direct actions to the workers of the campus so that they can be more aware of the sustainable actions being taken
Technologic	1. Data Management 2. Technological Change	1. Depending on the Digital Twin Implemented this can have impact in terms of the effort to do an appropriate Data Management 2. There will be space for a Technological Hub (for green energy technologies) in the Living Lab so this dimension will be very visible within the Probono Project at Porto. These technologies will be low TRL ones to identify future opportunities at a larger scale.
Legal	1. Data Protection 2. Construction Law	1. This is a critical for Sonae as group and as a company. Strick GDPR policies are in place and PROBONO will fit in this rule and all shared information within the project must be validated first. The information is more related to companies rather than individuals (specially on the Energy Community dimension) 2. Construction Law in Portugal as well as new energy projects permitting have their own specificities that need to be complied. Internal teams can respond to this challenge as well as certified providers.
Environment	1. Urban Heat Island 2. Renewable Energy	1. This will not be a question for the Porto LL 2. Renewable Energy is one of the main pillars of the Porto LLab intervention. On Probono it is considered to have an expression of the

		implementation of several Green/Renewable Energy solutions as well as an Energy Community within the companies that share the campus space for better optimization.

Table 15: Porto LL PESTLE Analysis

4.4 Aarhus

Pestel Item	Elements that are different with your LL	Why is it different?
Politics	1. Paris Agreement 2. Citizen Involvement	1. AU's goal for 2025 is to reduce the university's CO2 emissions by 35% against a 2018 baseline, and the goal for 2030 is to reduce the university's C02 emissions by 57% against a 2018 baseline. These ambitious goals live up to the Paris Agreement and the Danish government's goal of reducing carbon emissions by 70% in 2030 against a 1990 baseline. 2. The GBN area of Aarhus LL is mainly academic campus (AU BSS) besides a start-up hub (the kitchen 2.0), and the major impact will reach the ~ 2500 students and staff that every day go to the campus or may join the events in the start-up hub.
Economic	1. Green Finance 2. GDP per habitant	1. One of the major challenges for the green transition in Aarhus is to translate sustainable ideas and research into concrete actions. Aarhus

		is a stronghold for innovation and the architecture design industry. Connecting industry and research creates significant potential for a green transition with the focus on real and scalable actions. The specific focus of the Aarhus LL is on optimizing and achieving a DGNB Gold Rating. 2. GDP/habitant in Denmark = ~ 60 k€
Social	1. User Acceptance 2. Lifestyle 3. Education	1. The users are different (i.e. the area is not a living area, and instead is an educational area to study and work). 2. It will affect the education and workplace of the users and not their living area so the impact will be different. 3. The social dimension of the LLab will make direct actions to the students and staff of the campus so that they can be more aware of the sustainable actions being taken
Technologic	1. Data Management 2. Technological Change	1. All the data produced by the AU LL will be treated per GDPR requirements. AU has data for all in-use buildings. The following institutional resources at AU will be utilized to ensure compliance with relevant ethical and data protection procedures: (1) The AU Data Protection Officer (DPO) will be consulted to ensure the project

		handles personal information compliant to GDPR; (2) The AU central Ethical Committee will be consulted regarding ethical issues and relevant approval will be obtained; (3) Lawyers at the AU Technology Transfer Office will be consulted in legal matters, if necessary. 2. Depending on the Digital Twin implemented this can have an impact in terms of the effort to undertake appropriate Data Management. In this regard, integration or at least compatibility with the existing Dalux facility management system should be reviewed when developing the digital twin infrastructure to ensure that there are no technical complications or barriers to deploying the digital twin system. The existing AU digital team who are managing the electricity, heating, and water consumption of currently operational buildings should be consulted to ensure that there are no unforeseen conflicts or barriers.
Legal	1. Construction Law	1. Construction Law in Denmark is governed by the Danish building regulations and specificities (BR18) that need to be complied with. Furthermore, the backbone of the Aarhus LL is that there is governance in

		place to use DGNB as the method to reach its sustainable goal.
Environment	1. Urban Heat Island 2. Renewable Energy	1. Given the GBN's maritime location in a low-density area with surrounding green space, along with the prevailing Danish climate, it is not expected that the urban heat island effect will be a major consideration for AU LL. 2. AU buildings draw on the unique district heating system owned and operated by Aarhus Municipality (AffaldVarme Aarhus). It also supplies electricity to AU buildings. The district heating system is fed by public and private sector heat producers, including Combined Heat and Power (CHP) plants that operate using waste-to-power (e.g. one such plant in Waste Centre Lisbjerg), biomass (plants fueled by straw and woodchips), and seawater heat pumps.

Table 16 : Aarhus LL PESTLE Analysis

4.5 Prague

Pestel Item	Elements that are different with your LL	Why is it different?
Politics	1. Paris Agreement 2. Citizen Involvement	1. The Czech Republic signed the Paris Agreement in 2017 and in 2020 committed to reach carbon neutrality in 2040 on all of its operations, so even more ambitious targets. 2. The GBN area is a part of university campus of the Czech Technical University in Prague. The major impact will be on about 20000 citizens who are working or studying in the campus area and its surroundings on daily basis.
Economic	1. Green Finance 2. GDP per Habitant 3. Energy/Material Cost	1. Following the information on (1) it is also clear that it is part of CTU´s vision to become "greener" and more sustainable, on the next years/decades so it will give a boost to all the projects that contribute for this target. 2. GDP per habitant in the Czech Republic = 24k€ GDP per habitant in Prague = 54k€. 3. Reuse of construction materials and reduction of the number of materials and components used, in order to reduce the embodied energy of buildings. The specific materials and components will be specified within the

		design stage with the support of the CTU specialists.
Social	1. User acceptance 2. Lifestyle 3. Education	1. The users are different (not a living area, but a work/study area) and also there are companies involved. 2. For most users, it will affect mainly the workplace and not their living area. However, the impact will be different for each group of users. 3. The social dimension of the LL will make direct actions to the workers of the campus so that they can be more aware of the sustainable actions being taken.
Technologic	1. Data Management (DT) 2. Technological Change	1. Depending on the Digital Twin Implemented this can have impact in terms of the effort to do an appropriate Data Management. DT is to evaluate best solutions for energy and resource efficient building design. 2. There could be space for further technological development on university level focusing on green energy technologies (cooperation between more faculties of CTU).
Legal	1. Construction law 2. Data Protection	1. Construction Law in the Czech Republic as well as new energy projects permitting have their own specificities that need to be complied. Internal

		teams can respond to this challenge as well as certified providers. 2. The data produced by the Prague LL will follow GDPR requirements.
Environment	1. Urban Heat Island 2. Resilience	1. This will not be applied in the Prague LL. 2. Highly energy-efficient building designs adapted to local environments and climate conditions will be applied.

Table 17 : Prague LL PESTLE Analysis

5 From the Living Lab towards Green Building Neighbourhoods

This section lists some recommendations for PROBONO project, that could inspire the transition between the LL and the GBN, based on the documentation of the following resilience or rehabilitation projects developed at the district of neighbourhood scale around Europe:

Project	Objective	Availability
▪ **WEDISTRIC Heating & Cooling Solutions**	▪ Development of districts of heating and cooling	▪ Link here
▪ **Recovery, Transformation and Resilience Plan for the City of Madrid**	▪ Development of a plan to improve Madrid's resilience in the framework of the Sustainable Development Goals	▪ Link here
▪ **TURNKEY RETROFIT**	▪ Development of an integrated home renovation service through a digital platform	▪ Link here
▪ **Southmead Regeneration**	▪ Local regeneration of Southmead suburb in England based on local residents' participation.	▪ Link here

Table 18: Resilience or rehabilitation projects at the district of neighbourhood scale.

From the analysis of these reports, it is possible to identify some common initiatives and activities that are crucial for the fully and successfully implementation of urban resilient or rehabilitation projects:

- Works of renovation and improvement of buildings for efficient energy consumption and adoption of renewable energy solutions (Wedistric, RTRP and Turnkey):
    - Installation of heat solar panel; photovoltaic panels and heat pumps.
    - Installation of systems to reduce and monitor energy consumption.

- Stakeholders' participation and coordination during all the different stages of the project development and implementation (Wedistric, Southmead, RTRP and Turnkey):
    - Citizen's involvement is crucial for the acceptance and maintenance of the project in the long-term.
- Urban rehabilitation and creation of green areas to reduce climate change effects and impacts of urbanization (Southmead and RTRP), such as flooding, urban heat island, air pollution, biodiversity lost, or low accessibility to green spaces:
    - Integration of sustainable urban drainage systems or nature-based solutions, such as green roofs, drainage gardens, permeable paving for parking lots or urban parks.
    - Creation of hub' for public services (such as library and health center) or green energy technologies.
- Clear environmental policy that regulates energy efficiency and energy generation, greenhouse gases emissions limits, and waste management.

Specific activities are proposed or being implement according to the objective of each project, and some of them could be applied in the context of PROBONO project. Therefore, some of those initiates as well as recommendations and key criteria of attention for their success implementation at the neighbourhood scale, are listed below. In addition, the perspectives mentioned previously in the PESTLE analysis of the different LL are pointed out with the objective of projecting the building to neighbourhood scale transition.

WE DISTRIC	**PROBONO**
Objective: Development of districts of heating and cooling (DHC)	*Objective: Development of Green building neighborhoods*
Activities developed in specific project vs. Perspectives mentioned in PROBONO Deliverable	
Technological	
Renovation and works for energy efficiency of buildings and adoption of Renewable Energy Sources (RES) technologies, such as	Installation of photovoltaic systems in the roof's building (e.g., Brussels, Madrid, Prague and Porto LL).

installation of heat solar panel, photovoltaic panels and heat pumps. Solar thermal technology seems to be a good option to explore in DHC systems, specially the southern of Europe. *Positive Impact:* Retrofit and expand District Heating (DH) networks will make an easier connection of new or existing office buildings and owned housings. *Attention:* Conventional solar thermal panels do not have a high-performance efficiency which makes a new technological solution should be found.	
The main RES exploited in DHC case studies corresponds to the biomass, in fact this is most widely used renewable energy for heating today. *Recommendation:* Storage systems and digitalization have to be developed in order to provides energy to the buildings in the most efficient and performant way.	Connection of buildings to DH network fed by biomass, seawater heat pumps and others (e.g., Mardid and Aarchus LL).
The EU Energy Performance of Buildings Directive (2018/844/EU) promotes the smart technologies in buildings by installing systems for automation and control of energy consumption.	In the process of renovation of the LL, systems and devices for the efficient use of energy should be installed (e.g., Brussels, Madrid and Porto LL).
Installation of fuel cells into data centers in urban areas, to make waste heating recovery more efficient.	

Recommendation: The recovered waste heat could have a direct use in DH networks, or for use in hospitals, hotels, or laundries. *Recommendation:* Operation of small data centers in urban locations on natural gas, or biogas (created from the urban waste), or later hydrogen, to produce prime power for urban data centers with direct waste heat recovery has the advantage of reducing power grid congestion. *Attention:* Location of the data center powered by fuel cells in urban areas and compatible with the urban masterplan. Key criteria to consider fuel cell installation: ▪ Legislation for i) viable expansion of DH and ii) waste heat recovery (WHR). ▪ Agreement of heating network owners for heat recovery integration. ▪ Full knowledge on the local district heating system.	
Political aspect	
Updated national policy that promotes energy efficiency, regulates thermal standards for newly built buildings, establish emissions limits, and defines the conditions for implementation and promotion of energy cogeneration. Energy and climate policy in line with the EU directives and the Paris Agreement.	Local policy that promotes sustainable neighborhoods and regulates construction standards, and conditions of energy co-generation (success of DH in Sweden). Energy and climate policy in line with the EU directives and the Paris Agreement (e.g., Brussels, Madrid, Porto, Aarchus, Prague LL).

Social	
Stakeholders' acceptance of the vision, target, process and shared responsibility is crucial during all the phases of development and implementation of the DHC projects. *Recommendation*: The lack of awareness in energy efficiency benefits in buildings among stakeholders, end-consumers and policymakers can be addressed through mass-media channels. This will require the creation of specialized capacities for providing information, support and guidance instruments.	Citizen involvement and acceptance is crucial element of the implementation and maintenance of Living Lab (e.g., Brussel, Madrid, Porto, Aarchus, Prague LL).
The citizens favor the transition to more sustainable and green technologies, to mitigate climate change and reduce urban air pollution.	The citizens favor the transition to more sustainable urban living environment.
Energy and building efficiency projects can create jobs linked to energy savings.	Green neighborhood projects favor the creation of jobs.
The implementation of the wedistrict project will generate state-of-art knowledge transfer opportunities to the interested stakeholders allowing their upskilling.	The implementation of GBN will serve as technical, legal, and financial evidence of GBN success (e.g., Madrid LL). In educational sites as a school or a university, GBN development projects favor stakeholder's awareness generation.
Environmental	

Low carbon district networks through the development of renewable district heating and cooling networks. Example: Equinix *Recommendation:* Utilization of renewable energy sources (mainly biomass and solar energy) for districts of heating and cooling purposes.	Use of different renewable energy sources in the LL. Involvement of the LL in a Renewable Energy Community, to produce and share energy through renewable energy sources (e.g., Brussels and Porto)
Perspective to explore: Potential regional circular economy: Turning urban waste into biogas to operate efficient fuel cells.	Development of a compost project in the LL (e.g., Brussels).

Table 19: WE DISTRIC vs. PROBONO Initiatives.

Southmead Regeneration	**PROBONO**
Objective: Residents' participation in the local redevelopment plan of Southmead suburb in England.	Objective: Development of Green building neighborhoods
Activities developed in specific project vs. Perspectives mentioned in PROBONO Deliverable	
Social	
▪ Protect the future vitality and sustainability of neighborhood by ensuring amenities remain available to local people, e.g., accessibility of population to products of the basic food basket. ▪ Creation of library/health center hub to improve service delivery and	▪ Project development according to local masterplans. ▪ Citizen's participation in the redevelopment projects of the LL. ▪ Creation of a technological hub' in LL.

accessibility for disadvantaged groups.	
Environmental	
▪ Investment in underground sustainable urban drainage (SUDs) and associated public realm improvement works to reduce flood risk, improves the environment and the accessibility to green areas. ▪ Improves the quality of local parks and playgrounds	▪ Installation of green infrastructures or Nature-based solutions, to address the Urban Heat Island effect also can serve to reduce flood risk and improve the green areas accessibility.

Table 20: Southmead vs. PROBONO Initiatives

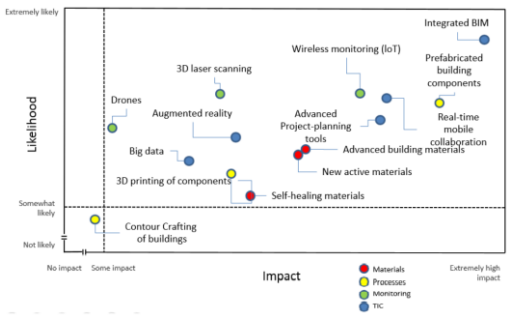
Recovery, Transformation and Resilience Plan for the City of Madrid	**PROBONO**
Objective: Plan to *improves the live and work conditions in Madrid, in the framework of the SDD: more sustainable, more digital, and more inclusive city.*	Objective: Development of Green building neighborhoods.
Activities developed in specific project vs. Perspectives mentioned in PROBONO Deliverable	
Technological	
▪ Energy rehabilitation of existing buildings and improvement of the energy efficiency. ▪ Integration of renewable energy into municipal buildings, increase of solar	▪ Creation of a Renewable Energy Community and installation of photovoltaic systems in schools (e.g., LL Brussels, LL Porto)

thermal generation through the installation of solar panels. ▪ Production of renewable energy close to municipal consumption centers. ▪ Plan of energy rehabilitation of houses and consumption monitoring of rehabilitated buildings. ▪ Installation of more efficient public lighting through the implementation of LED technology and intelligent lighting.	▪ In the process of renovation of the LL, systems and devices for the efficient use of energy should be installed.
▪ Construction of a Data office for managing the data generated by the city, using big data techniques and artificial intelligence, to advance evidence-supported management. ▪ Implementation of 5G infrastructure in the city and all the municipal areas, in collaboration with operators and universities. ▪ Ensure the essential cybersecurity of all elements involved in the digital transformation: assets, infrastructure, communications, services and citizens. ▪ Increase the sensorisation and digitalization of all urban assets to achieve a more efficient, sustainable, competitive and inclusive city.	▪ Data collection is crucial for monitoring the quality of the building and make more accurate simulations in the virtual word (e.g., Brussels, Porto, Aarhus, Prague). ▪ Exploration of building IOT technologies to measure temperature, movement, fire risk, etc.

Social	
▪ Rehabilitation of degraded homes and urban environments. ▪ Creation of several urban centers that provides different amenities and leisure places (polycentric approach). ▪ Promote and facilitate digital training for citizens and companies.	▪ Urban redevelopment of program managed by the privately-owned company distrito castellana norte (Madrid LL)
Environmental	
▪ Increase in the quantity and connection of urban green areas. ▪ *Positive Impact:* adaptation to climate change effects and urban heat island, increase the number of green areas, improvement of ecological connectivity, and promotion of social cohesion. ▪ Attention: inclusion and participation of citizens	▪ Climate risk and vulnerability assessment of the living lab building could be performed: exposition and sensitivity evaluation.
▪ Green economy promotion: Transformation of neighbourhoods as a productive resource, activating unused plots and revegetating its open space and underused roofs. *Positive Impact*: Favors entrepreneurship, food fruit and vegetable production, and marketing of organic products and hospitality	▪ Green roof retrofit of existing building.

▪ Optimize the recovery of materials and recycling, minimizing landfill, and limiting energy recovery for non-waste recyclable. ▪ Construction of a new organic matter composting plan, construction of a leachate treatment plant.	▪ Installing recycling bins for different waste streams, such as organic or paper, for development of compost recycling.

Table 21 : Recovery, Transformation and Resilience Plan for the City of Madrid vs PROBONO Initiatives

TURNKEY RETROFIT	**PROBONO**
Objective: Development of an integrated home renovation service through a digital platform *Solutions4Renovation*	Objective: Development of Green building neighborhoods.
Activities developed in specific project vs. Perspectives mentioned in PROBONO Deliverable	
Technological	
Most likely technologies to be exploited in the construction building sector:  *Recommendation:* Energy rehabilitation projects should include an integrated solution from design and engineering to the	▪ Renovation building works includes the integration of LML, BIM or digital twin, and the installation of IOT sensors for energy monitoring improvement (e.g., Brussels, Porto, Aarchus, Prague). ▪ Creation of a Renewable Energy Community and installation of photovoltaic systems in schools (e.g., Brussels, Porto)

execution of the project. Therefore, companies should: ▪ Improve knowledge development internally: insulation, ventilation, airtightness, installation of renewable energy systems, etc ▪ Improve industry-level collaboration with other suppliers as part of a value chain integration strategy.	
Political	
Energy rehabilitation projects are favored by a stable and favorable policy towards energy efficiency that includes: ▪ Financial incentives for individual but also for social housing ▪ Professional trainings: know-how and regulatory changes ▪ Public support: energy savings advices, energy renovation advice, renovation professional directory, energy audits According to French legislation, the construction sector should include: ▪ BIM ▪ Augmented workers and equipment (AI help human decision making, augmented reality, connected workers)	

▪ Augmented construction products (IoT, connected objects, green products) ▪ Big data	
Environment	
Integration of a quality (certification) mark for renovation favors the involvement of stakeholders in rehabilitation projects.	Sustainable certifications obtention of DGNB, such as LEED or BREEAM (e.g., Madrid LL).

Table 22 : TURNKEY RETROFIT vs PROBONO Initiatives

6 Conclusion

This first deliverable of Task 1.4 therefore sets up the first methodological building blocks to be followed to carry out a PESTLE analysis by local decision-makers. It is indeed impossible to develop a generalized PESTLE analysis for GBN because the context plays too important a role in their implementation. The completion of the PESTLE analysis will feed the reflections for obtaining the DGNB and ISO37101 certifications.

The Brussels PESTLE analysis provides a concrete example of what this analysis can look like. Indeed, the choice of Brussels LL allowed a quick and rich analysis with many local actors and a central role with a sensitive population specific to schools. The numerous sub-categories of studies identified with the partners were detailed in this analysis and allowed the other representatives of LL to identify the key points concerning them in this PESTLE analysis and to indicate their difference with Brussels. A severity score as well as adaptation solutions have been studied and will have to be developed to enrich the objective of being DGNB certified and to be consistent with the ISO37101 standard.

This analysis and this first deliverable will be improved as the PROBONO project progresses with A more guided and pushed methodology for local actors to realize their PESTLE Analysis. The goal will be to have a methodology that will lead to a roadmap of transition to a GBN

This analysis is central and crucial in the deployment of GBN since the obstacles linked to the surrounding context are identified. Moreover, the solutions are proposed, which makes it possible to anticipate the proper deployment of GBN.

References

[1] World Green Building Council, About Green Building: What is green building?, https://www.worldgbc.org/what-green-building

[2] European Green Deal

[3] European Commission, SET-Plan Action 3.2, https://setis.ec.europa.eu/system/files/setplan_smartcities_implementationplan.pdf

[4] Official Journal of the European Union, June 5th 2019, Directive (EU) 2019/944 of the European Parliament and the Council of 5 June 2019 on common rules for the internal market for electricity and amending Directive, https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32019L0944

[5] Official Journal of the European Union, December 11th 2018, Directive (EU) 2018/2001 of the European Parliament and of the Council of 11 December 2018 on the promotion of the use of energy from renewable sources, https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32018L2001

[6] European Commission, Joint Research Centre, Gervasio, H., Dimova, S., Model for Life Cycle Assessment (LCA) of buildings, Publications Office, 2018, https://data.europa.eu/doi/10.2760/10016

[7] Lice Cycle Initiative, Social Life Cycle Assessment (S-LCA), https://www.lifecycleinitiative.org/starting-life-cycle-thinking/life-cycle-approaches/social-lca/

[8] European Commission, Life-cycle coasting, https://ec.europa.eu/environment/gpp/lcc.htm

[9] ADEME, RESALLIENCE, French Ministry of Ecological Transition, March 6th 2022, https://globalabc.org/resources/publications/adaptation-building-sector-climate-change-10-principles-effective-action

[10] Comment conduire une analyse PESTEL. https://springworks.ch/comment-conduire-une-analyse-pestel/

[11] ISO/DIS 37123(en). Sustainable cities and communities — Indicators for resilient cities https://www.iso.org/obp/ui/#iso:std:iso:37123:dis:ed-1:v1:en

[12] Schiavo, F.T.; Magalhães, C.F.d. Smart Sustainable Cities: The Essentials for Managers' and Leaders' Initiatives within the Complex Context of Differing Definitions and Assessments. Smart Cities 2022, 5, 994-1024. https://doi.org/10.3390/smartcities5030050

[13] United Nations / Framework Convention on Climate Change (2015). Adoption of the Paris Agreement, 21st Conference of the Parties, Paris: United Nations. Available on: https://ec.europa.eu/clima/eu-action/international-action-climate-change/climate-negotiations/paris-agreement_fr

[14] National Energy and Climate Plan 2021-2030 : Context, Objectives, Policies and Measures. 12/18/19. Available on: https://energy.ec.europa.eu/select-language?destination=/node/1

[15] Green Finance Platform, Explore Green Finance. Available on: https://www.greenfinanceplatform.org/page/explore-green-finance

[16] The World Bank, GDP per capita (constant LCU), https://data.worldbank.org/indicator/NY.GDP.PCAP.KN

[17] Natalie MARCHANT, "This is how climate change could impact the global economy", WORLD ECONOMIC FORUM, Article, June 28th 2021, https://www.weforum.org/agenda/2021/06/impact-climate-change-global-gdp/#:~:text=The%20largest%20impact%20of%20climate,the%20Swiss%20Re%20Institute%20warns.

[18] Fiches communales d'analyse des statistiques locales en région bruxelloise – Fiche n°4 commune de Brussells-Ville, https://www.ccc-ggc.brussels/sites/default/files/documents/graphics/fiches-communales/2010/04_Brussells-vlle_fr.pdf

[19] Economy, 23 July 2021, Mandatory risks - Natural disasters, https://economie.fgov.be/fr/themes/services-financiers/assurances/incendie-et-catastrophes/autres-risques-assures/risques-obligatoires/risques-obligatoires

[20] QinglinQi ; FeiTao ;TianliangHu ;NabilAnwer ; AngLiu ; YongliWei ; LihuiWang ; A.Y.C.Nee : Enabling technologies and tools for digital twin : Context, Objectives, Policies and Measures, 10/01/19, https://www.sciencedirect.com/science/article/abs/pii/S027861251930086X

[21] Enless Wireless, Transmetteur de Température avec capteur intégré, https://enless-wireless.com/fr/products/transmetteur-de-temperature-avec-capteur-integre-2/

[22] Rafael Sacks ; Ioannis Brilakis ; Ergo Pikas ; Haiyan Sally Xie ; Mark Girolami: Construction with digital twin information system: 09/21/20, https://www.repository.cam.ac.uk/bitstream/handle/1810/313570/construction_with_digital_twin_information_systems.pdf?sequence=3

[23] Ahmed Hefnawy ; Abdelaziz Bouras ; Chantal Cherifi : IoT for Smart City Services : Lifecycle Approach : 06/01/17. https://hal.science/hal-01531630/document

[24] Oke, T. R. (1982). The energetic basis of the urban heat island. Quarterly Journal of the Royal Meteorological Society, 108(455), 1–24. https://doi.org/10.1002/qj.49710845502

[25] Oke, T. R. (1987). Boundary Layer Climates (2nd ed). Routledge.

[26] Castellanos, L. Deploying nature-based solutions in urban areas: thermal performance and urban feasibility across scales. École des Ponts ParisTech, 2022. English. NNT:2022ENPC0013. tel-3764898

[27] EPA, 2022. Heat Island Impacts. Available on: https://www.epa.gov/heatislands/heat-island-impacts

[28] Salamanca, F., Georgescu, M., Mahalov, A., Moustaoui, M., and Wang, M. (2014), Anthropogenic heating of the urban environment due to air conditioning, J. Geophys. Res. Atmos., 119, 5949– 5965, doi:10.1002/2013JD021225

[29] Cartographie des îlots de fraîcheur dans la Région de Bruxelles-Capitale. https://environnement.brussels/sites/default/files/ilots_de_fraicheur_ensemble.pdf

[30] Magalie Técher, Hassan Ait Haddou, Rahim Aguejdad. Characterization of the urban microclimate by the modelling of urban planning policies in France. Journal of Physics: Conference Series, IOP Publishing, 2021, 2042 (1), pp.012065. ff10.1088/1742-6596/2042/1/012065ff. ffhal-03513585

[31] Müller N, Kuttler W, Barlag AB (2014). Analysis of the subsurface urban heat island in Oberhausen, Germany. Clim Res 58:247-256. https://doi.org/10.3354/cr01195

[32] Hamdi, R. Estimating Urban Heat Island Effects on the Temperature Series of Uccle (Brussels, Belgium) Using Remote Sensing Data and a Land Surface Scheme. Remote Sens. 2010, 2, 2773-2784. https://doi.org/10.3390/rs2122773

[33] Moreno-Garcia, M.C. (1994). Intensity and form of the urban heat island in Barcelona. Int. J. Climatol., 14: 705-710. https://doi.org/10.1002/joc.3370140609

[34] Hidde van Ooststroom. August 30th 2011. Urban Heat Island adaptation through Urban Planning and Design : the struggle of the city of Los Angeles. Available on: https://frw.studenttheses.ub.rug.nl/1166/1/Master_Thesis.pdf

[35] Minnesota Pollution Control Agency (2010). Digging deep through school trash: a waste composition analysis of trash, recycling and organic material discarded at public schools in Minnesota. Available on: https://www.lrl.mn.gov/docs/2010/other/100992.pdf

[36] Tracking SDG 7. The Energy Progress Report. Available on: https://trackingsdg7.esmap.org/

[37] Hassan Qudrat-Ullah, Mark M.Akrofi, Aymen A.Kayal, April 2020, Analyzing Actors' Engagement in Sustainable Energy Planning at the Local Level in Ghana : An Empirical Study. Available on: https://www.mdpi.com/1996-1073/13/8/2028

[38] Global Center on Adaptation. May 4th 2022. Case Studies on Adaptation and Cliamte Resilience in Schools and Educational Settings. Available on: https://gca.org/reports/case-studies-on-adaptation-and-climate-resilience-in-schools-and-educational-settings/

[39] Light pollution map. Available on: https://www.lightpollutionmap.info/#zoom=4.00&lat=45.8720&lon=14.5470&state=eyJiYXNlbWFwIjoiTGF5ZXJCaW5nUm9hZCIsIm92ZXJsYXkiOiJ3YV8yMDE1Iiwib3ZlcmxheWNvbG9yIjpmYWxzZSwib3ZlcmxheW9wYWNpdHkiOjYwLCJmZWF0dXJlc29wYWNpdHkiOjg1fQ==

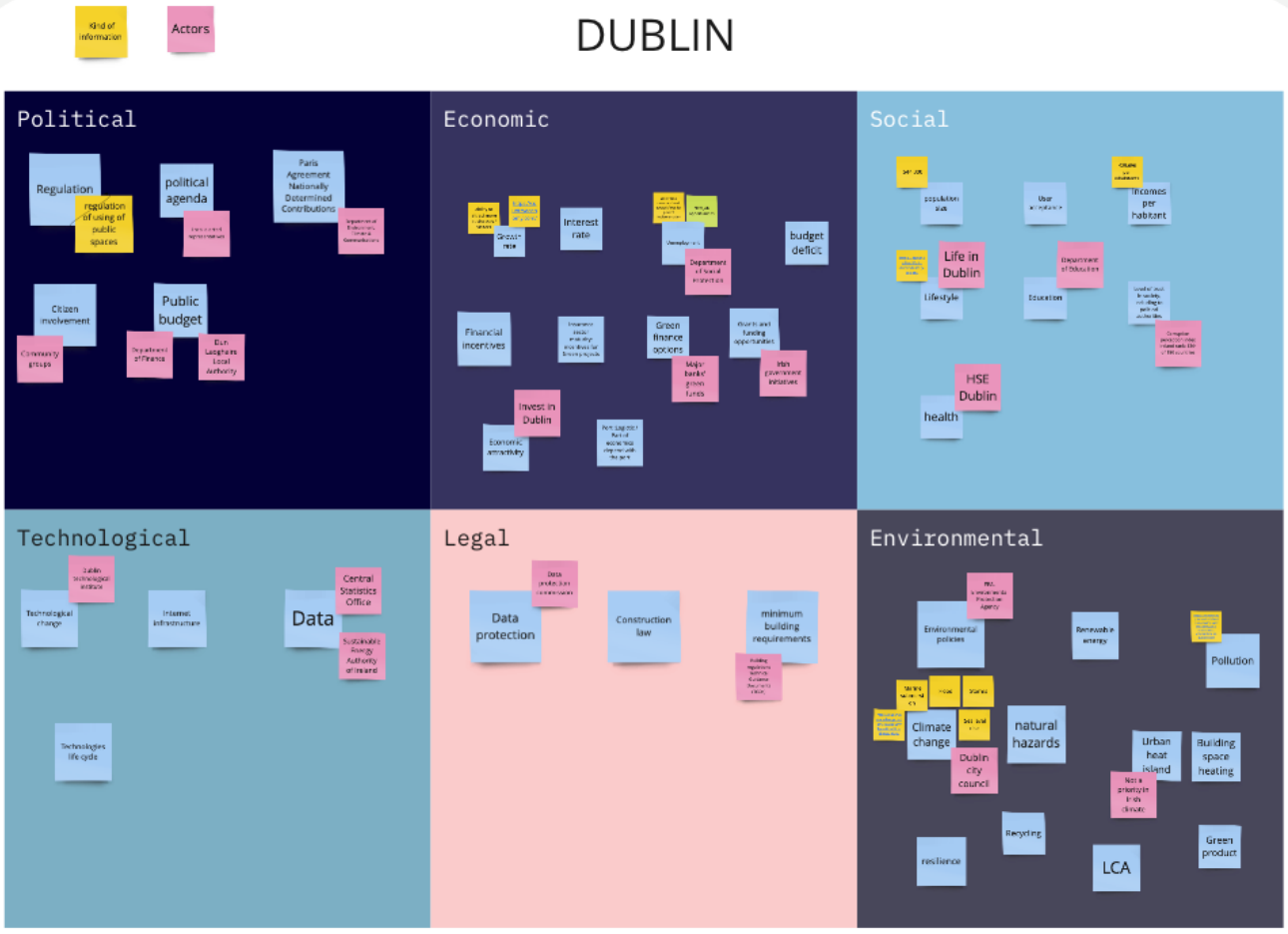
[40] European Air Quality Index. Available on: European Air Quality Index (europa.eu)

[41] European Environment Agency. Belgium noise fact sheet 2021. December 8th 2021. Available on: https://www.eea.europa.eu/themes/human/noise/noise-fact-sheets/noise-country-fact-sheets-2021/belgium

[42] Biotecture, 2018. Melcombe Primary School Greening, Hammersmith. Available on: https://www.biotecture.uk.com/portfolio/melcombe-school-greening/

ANNEXES

PESTLE Analysis Boards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Education
HSE Dublin
health
Technological
Data
Central Statistics Office
Legal
Data protection
Construction law
minimum building requirements
Environmental
Environmental policies
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Dublin city council
Recycling
Green product
resilience
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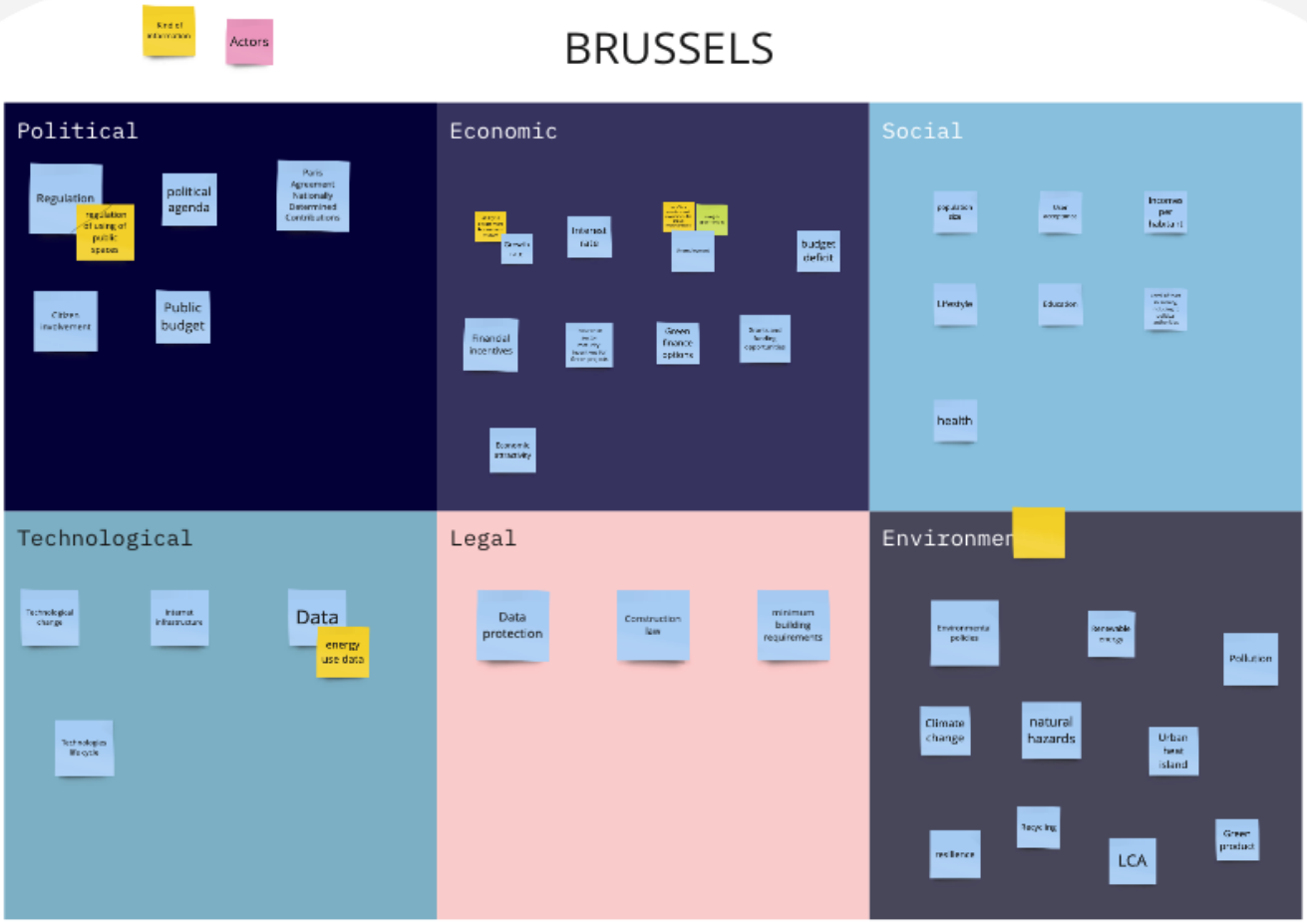
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Lifestyle
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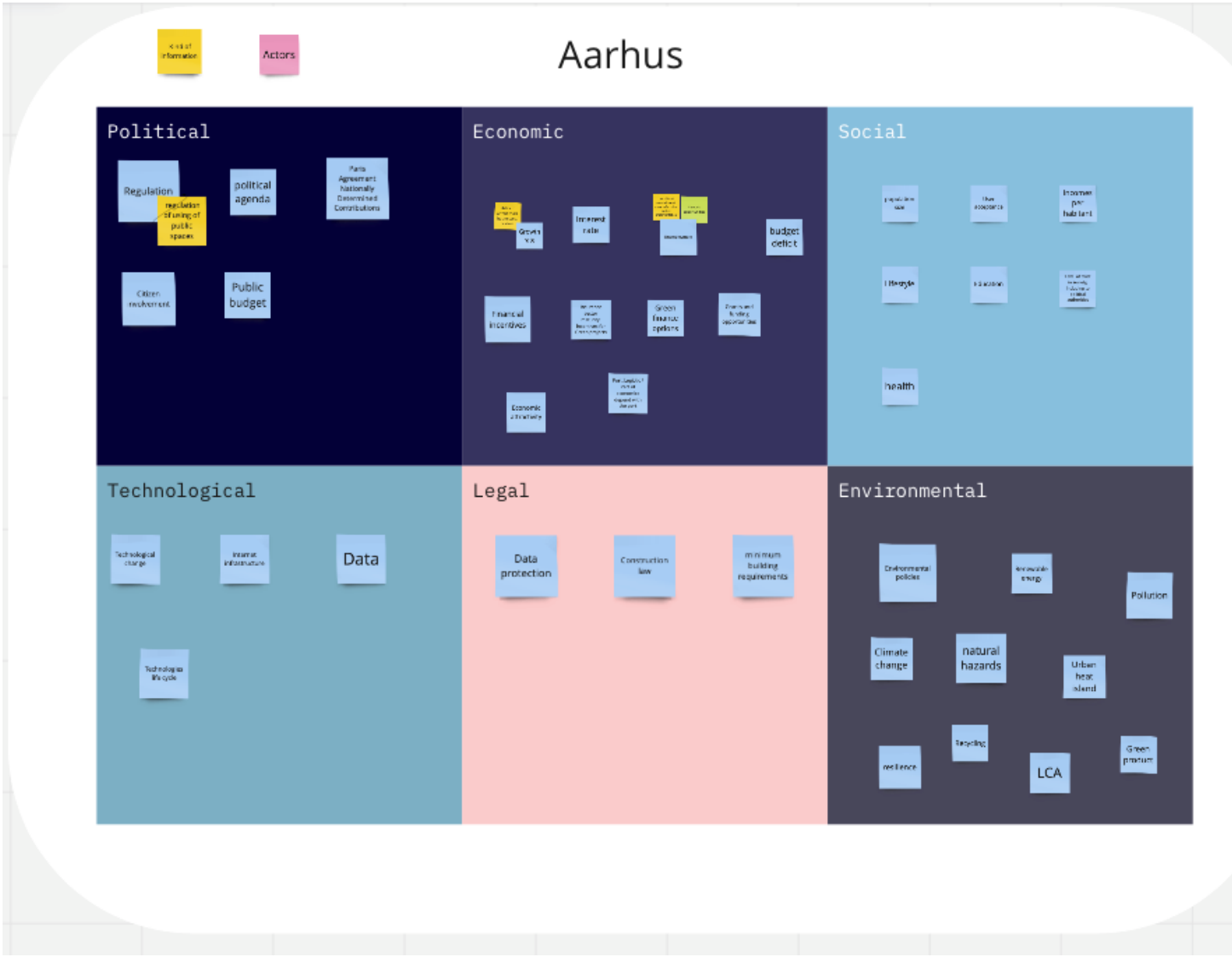
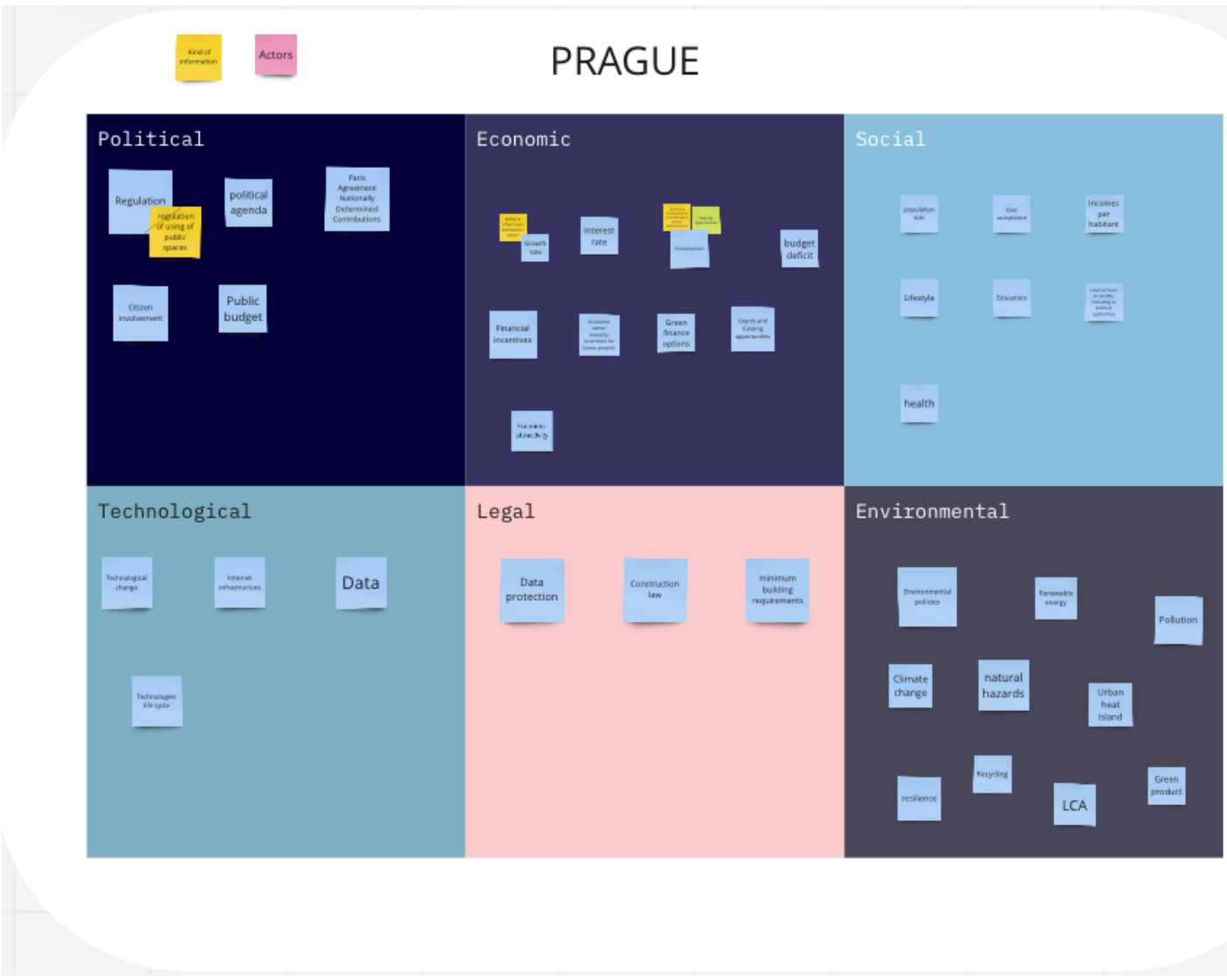
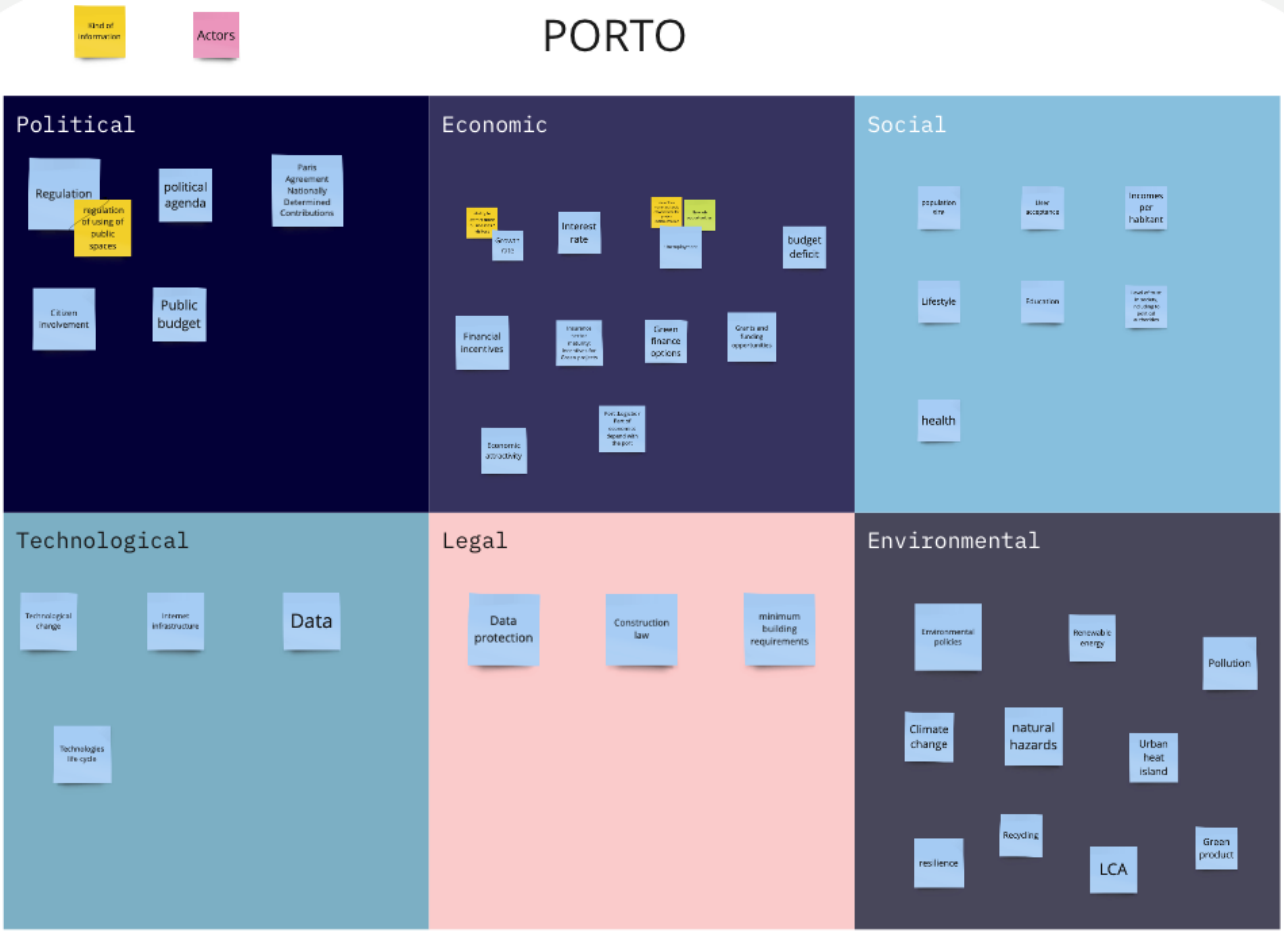
health
Technological
Technological change
Internet infrastructure
Data
energy use data
Legal
Data protection
Construction law
minimum building requirements
Environmen
Environmental policies
renewable energy
Pollution
Climate change
natural hazards
Urban heat island
Recycling
resilience
LCA
Green product


Actors
Aarhus
Political
Regulation
political agenda
Public budget
Economic
budget deficit
Financial incentives
Green finance options
Social
health
Technological
Data
Legal
Data protection
Environmental
Pollution
Climate change
natural hazards
LCA


Kind of information
Actors
PRAGUE
Political
Regulation
regulation of using of public spaces
political agenda
Paris Agreement Nationally Determined Contributions
Citizen involvement
Public budget
Economic
Growth rate
interest rate
budget deficit
Financial incentives
Green finance options
Grants and funding opportunities
Social
population size
user acceptance
incomes per habitant
Lifestyle
Education
health
Technological
Technological change
Internet infrastructure
Data
Technologies life cycle
Legal
Data protection
Construction law
minimum building requirements
Environmental
Environmental policies
Renewable energy
Pollution
Climate change
natural hazards
Urban heat island
resilience
Recycling
LCA
Green product


Actors
PORTO
Political
Regulation
political agenda
Paris Agreement Nationally Determined Contributions
regulation of using of public spaces
Citizen involvement
Public budget
Economic
Interest rate
budget deficit
Financial incentives
Green finance options
Economic productivity
Social
Lifestyle
health
Technological
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Technologies life cycle
Legal
Data protection
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minimum building requirements
Environmental
Environmental policies
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LCA
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